United States
Department of
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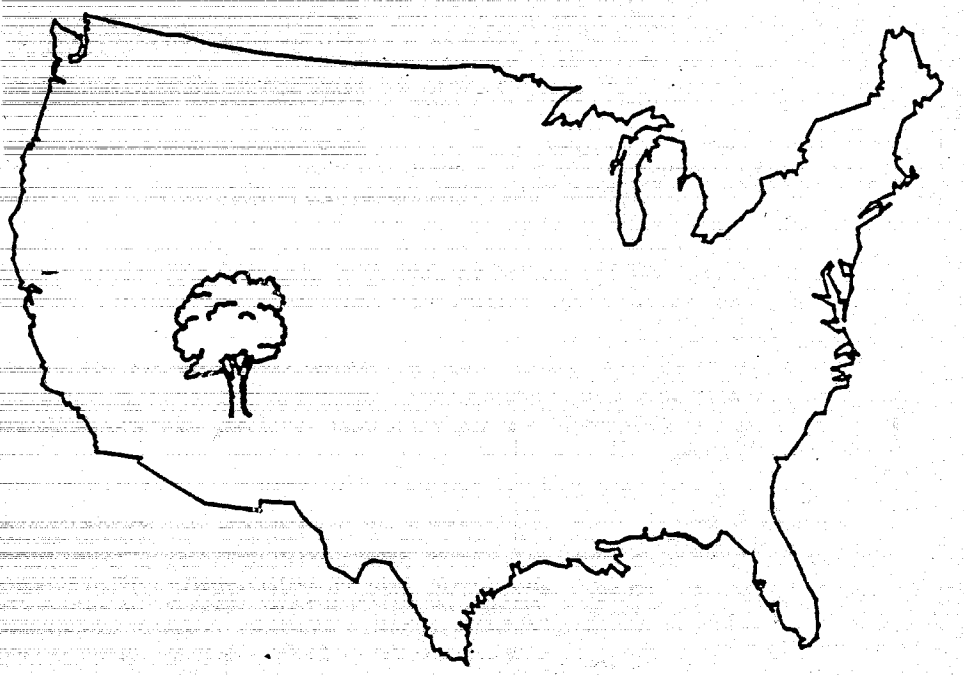
Soil Conservation
Service

Plant Materials Center
Los Lunas, New Mexico

Selecting Desirable Woody Vegetation For Environmental Mitigation and Controlling Wind Erosion And Undesirable Plants In The Rio Grande and Pecos River Valleys Of New Mexico



Five Year Interim Report (1983-87)

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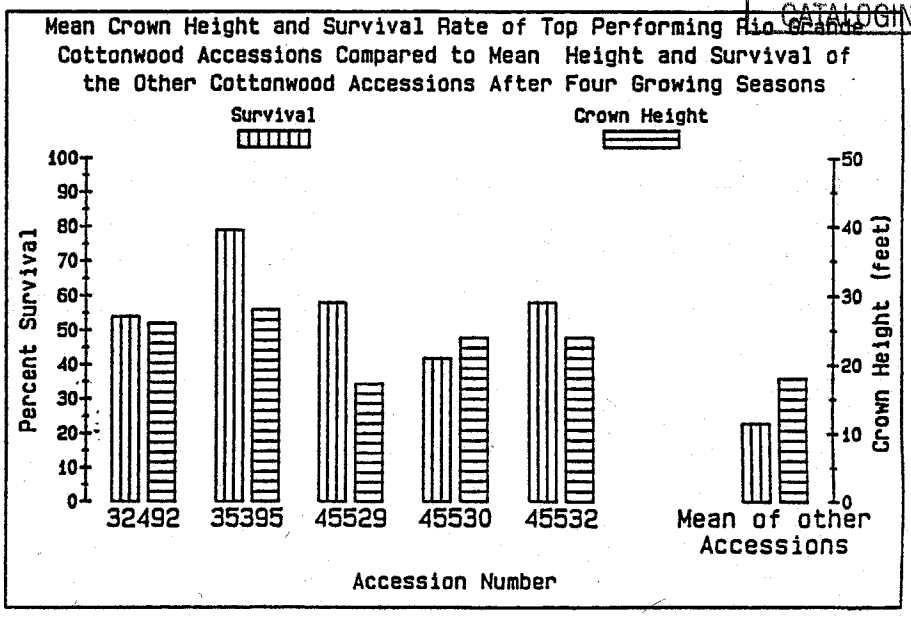
EXECUTIVE SUMMARY:

A cooperative agreement was developed between the USDA-Soil Conservation Service (SCS) Plant Materials Center (PMC) and the USDI-Bureau of Reclamation (BR) Rio Grande Project for the development and evaluation of plant material establishment and propagation techniques for erosion control purposes at Elephant Butte and Caballo Reservoirs, New Mexico. Work plans for three consecutive years have been developed annually by the BR and the SCS to coordinate the project activities of the two agencies.

The work plan for the 1987 calendar year (see Appendix A) was completed except for item 4, increasing the cutting blocks of the selected lines of black willow. Over 700 unrooted cuttings were delivered by January 26, 1987, and planted by BR at Percha Field. On-center evaluations of 32 Rio Grande cottonwood (*Populus fremontii* var. *wislizenii*) accessions, 7 black willow (*Salix goodingii*) accessions, and 7 hybrid poplar strains have continued since 1983. As can be seen in Figure A, the cottonwood accession from Belen (SCS 35395) is still superior in growth and survival compared to other accessions evaluated.

FIGURE A:



Off-center performance testing of native accessions and hybrid strains has also continued since 1983. Off-center testing for 1987 included plantings of 7 superior Rio Grande cottonwood accessions, 3 top performing western black willow accessions, and 4 hybrid poplar strains at four locations: Bernardo, Percha Field, Bosque del Apache National Wildlife Refuge and Los Lunas Plant Materials Center. The best performing accessions were from Belen, NM (cottonwood SCS 35395) and Pima County, AZ (willow SCS 52834). The hybrid poplar strains Jacometti, Caudina, and Incrassata also performed well.

The list of top performing accessions has been refined to 5 Rio Grande cottonwood accessions, 3 western black willow accessions, and 3 hybrid poplar strains. Increase blocks of 7 Rio Grande cottonwood accessions, 2 black willow accessions, and 4 hybrid poplar strains were established in 1986. The plant propagation study involving selected water soaking periods, 10 to 25 inch cutting lengths, and the root starter "Liquinox" (vitamin B, alpha naphphalene acetic acid and other substances) was continued. Previous studies showed soaking cottonwood or willow cuttings 10 to 14 days prior to planting enhanced survival. The longer cuttings tended to display the best survival and neither the "Liquinox" treatment nor soaking of the cutting longer than 5 days tended to enhance survival. A second propagation study was conducted comparing the effectiveness of a willow tea soak and a plain water soak on stimulating root growth of cottonwood cuttings of accession SCS 35395. There was no significant difference among the treatments; cuttings of either treatment rooted vigorously.

The establishment of at least 8 new increase blocks for 1988 of superior performing accessions of Rio Grande Cottonwoods and Western Black Willow was initiated. Each block will contain 1,000 trees of a single accession and hopefully yield about 1,000 trees per year by 1990, after the second growing season.

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INTRODUCTION:

If soil erosion along the Rio Grande and Pecos rivers and flood plains is not held in check, detrimental effects on the riparian habitat and the environment could accelerate. Due to the actions of man, the spread of undesirable species such as salt cedar (*Tamarix pentandra*) has been associated with the decline of the riparian and flood plain habitats. River channel maintenance activities, as mandated by law, can require mitigation measures such as revegetation.

Channel work along the Rio Grande has made it necessary for revegetation techniques to be formulated for environmental mitigation, erosion control, and biological control of undesirable species through shading. Consequently, a cooperative agreement was developed between the USDA-Soil Conservation Service (SCS) Plant Materials Center (PMC) and the USDI-Bureau of Reclamation's (BR) Rio Grande Project to study riparian plant materials and their establishment along the Rio Grande and Pecos rivers (see Appendix A). One goal of the agreement is to make commercially available for revegetation purposes superior strains of the following species: Rio Grande cottonwood (*Populus fremontii* s. *wislizenii*), Narrowleaf cottonwood (*Populus angustifolia*), Goodings or black willow (*Salix goodingii*), and Peach-leaf willow (*Salix amygdaloides*). A second goal is to provide better planting methods to establish the four species in the fastest and most economical way.

In addition to the cooperative agreement, annual work plans have been developed by the BR and the SCS to coordinate the project needs of the two agencies. The work plan for the 1987 calendar year was completed except for item 4, increasing the cutting blocks of the selected lines of black willow. New cutting blocks of both black willow and cottonwood will be established during this 1988 calendar year. Over 700 unrooted cuttings as requested in item 1 were delivered by January 26, 1987. Evaluations of genotypes of Rio Grande cottonwood, black willow, and hybrid poplars have continued annually since 1983. Increase blocks of 7 Rio Grande cottonwood lines, 2 black willow lines, and 4 hybrid poplar lines were established. Plant propagation and establishment techniques of selected lines of cottonwood, black willows, and hybrid poplars were evaluated.

PERFORMANCE EVALUATION OF RIO GRANDE COTTONWOOD AND BLACK WILLOW ACCESSIONS AS AFFECTED BY THREE PROPOGATION TREATMENTS (1984-87)

METHODS:

During the dormant period in January of 1984, 39 superior collections of Rio Grande cottonwood and black willow were taken in the Rio Grande Valley from Costilla, New Mexico south to the Fort Craig ruins near Elephant Butte Resevoir (Table 1, Figure 1). A few collections were obtained near Ojo Caliente, New Mexico, on the Ojo Caliente River and near Black Rock Lake at Zuni, New Mexico. Each accession (collection) consisted of 6 two to three year old sapling poles taken from a single tree which were later cut into 18 to 20 inch lengths and placed in cold storage to maintain dormancy.

In early March, cuttings were removed from cold storage and divided into 3 equal groups. A separate treatment was applied to each group. The treatments were as follows: (a) soaking for 10 to 14 days in a water bath at 74^{o}F, (b) misting at short periodic intervals in a mist chamber for 17 or 28 days, and (c) planting directly from cold storage to a sprinkler irrigated field. The cuttings receiving the mist chamber treatment were further divided into two equal groups. The first group remained in the chamber for 17 days (March 12 thru March 29). The second group remained in the mist chamber for 28 days (April 2 thru April 30).

Cuttings of each treatment were transplanted into separate adjacent plantings in Field 12 (Figure 2). All cuttings were installed in furrows with predug holes. The furrows were 300 feet in length, spaced 10 feet apart, and contained 9 plots. Each plot was comprised of 6 trees of a single accession spaced on 5.5 feet centers. Each plot was replicated twice in a total randomized design.

Annual field maintenance consists of the following treatments. Continuing through 1986, the planting was flood irrigated as necessary to maintain soil moisture (generally about five 2 inch applications per year). For the 1987 calender year the planting was not irrigated; moisture was mainly supplied by the ground water table through the root uptake. The ground water table generally remained at a 6 foot depth throughout the growing season.

For weed control, the plantings have been periodically cultivated and the herbicide glyphosate, "Roundup," was applied by hand spraying to control bindweed (*Convolvulus arvensis*) and Johnsongrass (*Sorgum halepense*). Both herbicide 2-4-D was also applied by hand spraying to controll bindweed. The herbicides were applied by hand spraying to keep drift from the applications to a minimum so the Cottonwood and Black Willows would not be significantly affected.

Cuttings that had successfully rooted in the sprinkler irrigated field were transplanted to Field 12 the following year (1985). Dead cuttings which had received the mist chamber treatment were removed and replaced with the sprinkler irrigated cuttings in rows 13, 14 and 15.

The four plantings have been evaluated annually since 1984 by monitoring plant survival, plant height, canopy width, stem diameter, branch abundance, leaf density and vigor. Tree height was measured with pole or an abney level. Bole diameter was measured with a Forester's Diameter at breast height (D.B.H.) tape. However, bole diameter was measured at ground level to avoid measuring several thin branches at breast height since the trees generally had multiple main stems.

The 10 to 14 day soak treatment received heavy emphasis in the selection process since it was the only treatment which included all the accessions. Therefore, in selecting the top performing accessions, the overall mean performance in all treatments was considered with the mean performance in the 10 to 14 day soak treatment. However, in this early four year period of this planting, no surviving accessions have been excluded from selection.

RESULTS:

The planting has been evaluated annually since 1984 (Tables 2 thru 6). The initial 1984 results of the three treatments were:

1) Cuttings soaked in water for 14 days averaged the best survival rate at 50 percent with some accessions having 100% survival.

2) Cuttings that received mist for 17 days averaged a moderate survival rate at 37 percent.

3) Cuttings that received mist for 28 days and those planted directly in the sprinkler system had the poorest average survival rate at 14 percent and 24 percent respectively.

The 1987 field evaluation revealed similar survival among treatments (Figure 3). Cuttings that were soaked 10 to 14 days prior to planting averaged the best survival rate at 41 percent. Furthermore, some accessions that were soaked 10 to 14 days had 80 percent survival or better after 3 growing seasons. The percent survival of the 17 day mist planting, 28 day mist planting, and the initial sprinkler irrigated planting were 26 percent, 10 percent and 12 percent respectively.

The top performing black willow accessions were collected in New Mexico at the following locations: San Acacia (SCS 9035372), San Antonio (SCS 9045531), and Ojo Caliente (SCS 9032491). Survival rates of these accessions ranged from 66 percent to 83 percent in the 10 to 14 day water soak treatment, and 46 percent to 75 percent considering the four treatments combined (Figures 4 and 5). Accessions numbers SCS 9032493 and 9045533 were the only other accessions with relatively good survival in the 4 treatments, but did not have the vigorous growth displayed by the top performers. The crown height and canopy width of the top performers after 4 growing seasons averaged 14 feet and 7 feet respectively in the 10 to 14 day soak treatment, and 13 feet to 8 feet respectively in the 4 treatments combined. Annual growth rate is averaging 3.5 feet in height and 1.8 feet in canopy width. These superior accessions averaged over 36 percent taller than other black willow accessions. Canopy width was only average in size relative to other accessions. However, canopy width among all black willow accessions had a narrow range of 6.6 feet to 9.4 feet. Consequently, the difference between the large canopies and the average may be insignificant.

The top performing Rio Grande cottonwoods were collected in New Mexico at the following locations: Bosque Del Apache National Wildlife Refuge (SCS 9045532), San Antonio (SCS 9045529 and 9045530), Bosque (SCS 9032492), and Belen (SCS 9035395). Survival rates of these accessions ranged from 67 percent to 83 percent in the 10 to 14 day soak treatment, and 42 percent to 79 percent in all 4 treatments combined (Figures 6A, 6B, 7A and 7B). Accessions numbers SCS 9032494 and 9045534 had similar survival, but did not have the vigorous growth displayed by the top performers. The height and canopy width of the top performers averaged 26 feet and 12 feet respectively in the 10 to 14 day soak treatment and 24 feet and 12 feet respectively in all four treatments combined. The canopy width of the top performers was not significantly different than the mean of the other accessions. Accessions with the largest canopy width (SCS 9035378, 9035374, 9035376, 9035378, 9035380, 9035382, 9035383, 9035385) generally had the poorest survival. These accessions were generally represented by a single tree per plot. The larger canopy width may be only an environmental response to the additional growing space which may have enhanced sunlight penetration and moisture availability. Consequently, the height and canopy width measurment maybe influenced by competition and not represent the ultimate potential of the genotype.

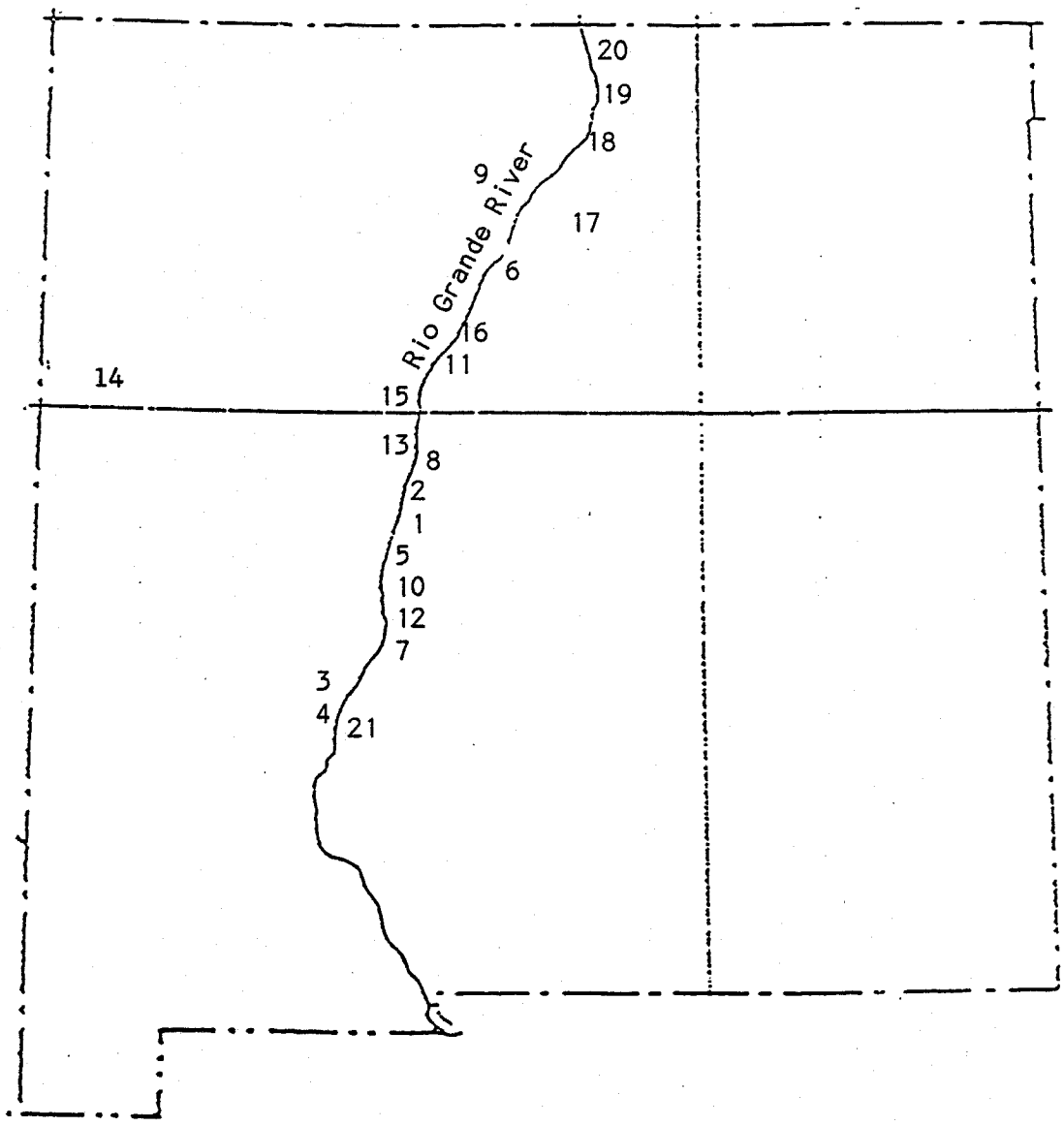
Accession number SCS 9035395 is still superior in all evaluation data and continues to be the most promising for release. The collection is a male selection. In a situation where natural reproduction is desired, planting this selection would only be recommended in conjunction with heterogamous. This is one reason that more than one selection is being considered for possible use in future revegetation projects.

We are not sure that accession SCS 9035395 is a Rio Grande cottonwood (*Populus fremontii*) because of its columnar growth form and large leaves. Consequently, we have initiated a genotype study with Dr. Ken Page (Professor of Biology, Post Doctrine at Utah University, Salt Lake City, Utah) to identify the species.

Table 1. Approximate Site Location for the Thirty-nine Accessions of Rio Grande Cottonwood and Black Willow.

	Accession Number	Species	Map Location	Approximate Site Location
1.	32492	Populus fremontii	1	Bosque, NM
2.	35395	Populus fremontii	2	Belen, NM
3.	45529	Populus fremontii	3	San Antonio, NM
4.	45530	Populus fremontii	3	San Antonio, NM
5.	45532	Populus fremontii	4	Bosque del Apache N.W.R.
6.	32490	Populus fremontii	5	Bernardo NM
7.	32494	Populus fremontii	6	Jemez, NM
8.	32496	Populus fremontii	7	Socorro, NM
9.	32497	Populus fremontii	7	Escondida, NM
10.	32499	Populus fremontii	8	Los Chavez, NM
11.	35369	Populus fremontii	9	Ojo Caliente, NM
12.	35370	Populus fremontii	10	San Acacia, NM
13.	35373	Populus fremontii	10	San Acacia, NM
14.	35374	Populus fremontii	4	Bosque del Apache N.W.R.
15.	35375	Populus fremontii	4	Bosque del Apache N.W.R.
16.	35376	Populus fremontii	11	Bernalillo, NM
17.	35377	Populus fremontii	12	Lemitar, NM
18.	35378	Populus fremontii	12	Lemitar, NM
19.	35379	Populus fremontii	12	Lemitar, NM
20.	35380	Populus fremontii	13	Los Lunas, NM
21.	35381	Populus fremontii	7	Escondida, NM
22.	35382	Populus fremontii	14	Black Rock, NM
23.	35383	Populus fremontii	7	Escondida, NM
24.	35384	Populus fremontii	15	Corrales, NM
25.	35385	Populus fremontii	16	Algodones, NM
26.	35386	Populus fremontii	17	Idlefonso, NM
27.	35388	Populus fremontii	18	Pilar, NM
28.	35389	Populus fremontii	19	Questa, NM
29.	35390	Populus fremontii	20	Costilla, NM
30.	35391	Populus fremontii	9	Ojo Caliente, NM
31.	35393	Populus fremontii	21	San Marcial, NM
32.	45534	Populus fremontii	21	San Marcial, NM
33.	32491	Salix Goodingii	5	Bernardo, NM
34.	32493	Salix Goodingii	1	Bosque, NM
35.	32495	Salix Goodingii	3	San Antonio, NM
36.	35371	Salix Goodingii	3	San Acacia, NM
37.	35372	Salix Goodingii	10	San Acacia, NM
38.	45531	Salix Goodingii	3	San Antonio, NM
39.	45533	Salix Goodingii	13	Los Lunas, NM

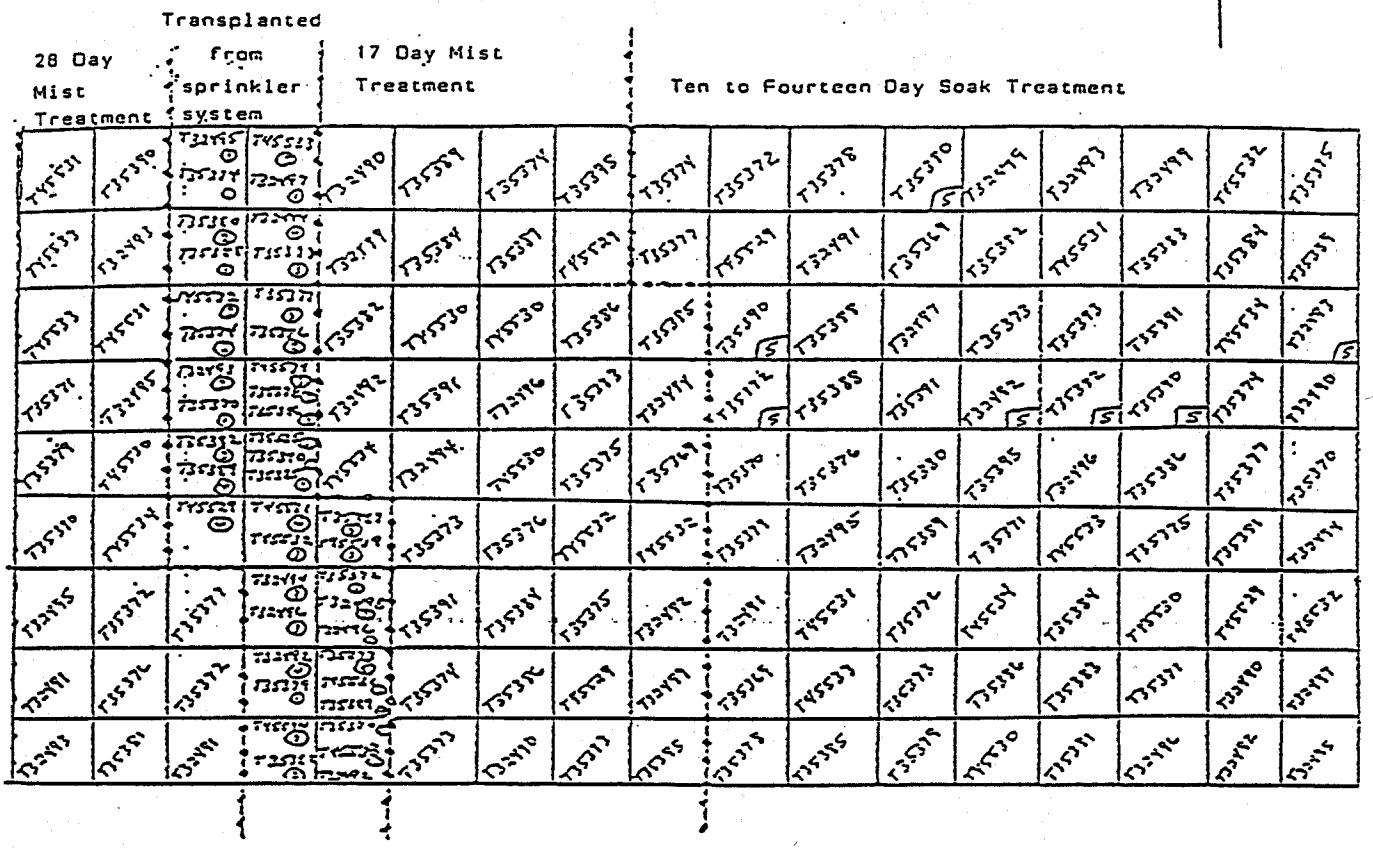
FIGURE 1: Map Showing The Locations Of 21 Collection Sites Of Rio Grande Cottonwood And Black Willow in New Mexico.[1]



[1]Due to the close proximity of some sites and the scale of the Map only 21 sites were delineated.

FIGURE 2: Diagram Of Rio Grande Cottonwood And Black Willow Planting for 1984

FIELD 12



Planted 6 trees in a single row per plot for each accession. Fewer trees planted if specified.

Table 2. Performance Summary of Cottonwoods and Black Willows to the Four Treatments Combined for 1984-1987.

Accession	Species	Replications	No. of Plants	Percent Survival	Average Tree Height (ft)				Average Canopy Width (ft)			Average Caliper (inches)				Average Foliage Leaf Density & Branch Abundance [1]			Vigor [1]		
					1984	1985	1986	1987	1985	1986	1987	1984	1985	1986	1987	1985	1986	1987	1985	1986	1987
32491	W	4	11	46	4.3	8.9	10.7	12.3	6.4	5.7	7.5	0.4	1.0	1.5	3.6	6/5	6/6	5/6	4	6	4
32493	W	4	15	63	2.6	5.2	6.2	9.8	6.5	5.4	6.6	0.4	0.9	0.5	4.5	5/5	8/8	5/5	6	8	6
32495	W	4	3	13	3.3	7.5	7.3	11.0	6.5	5.0	8.0	0.4	1.2	1.5	4.0	5/5	7/7	4/4	5	7	5
35371	W	3	6	33	3.9	7.6	9.8	14.0	7.0	6.8	10.3	0.4	1.1	1.6	5.8	5/5	5/6	4/4	5	6	4
35372	W	4	18	75	5.8	11.0	12.0	13.6	7.0	6.2	7.3	0.6	1.5	1.6	4.3	5/5	6/6	4/5	3	6	5
45531	W	4	15	63	4.5	8.8	10.8	14.3	7.7	7.3	9.4	0.4	1.3	1.6	3.4	5/5	6/5	5/5	4	6	5
45533	W	4	16	66	3.1	5.1	6.1	7.4	7.1	5.3	8.5	0.4	0.9	1.3	3.8	6/6	7/7	4/5	6	7	4
32490	RGC	4	9	38	5.1	9.1	14.4	19.5	7.6	10.0	14.0	0.9	2.0	3.9	6.1	6/5	5/5	3/3	5	6	4
32492	RGC	4	13	54	6.2	11.3	14.8	26.0	8.0	9.5	12.0	1.0	2.3	3.5	7.9	6/6	4/4	4/4	5	4	4
32494	RGC	3	8	44	6.5	11.8	16.4	17.3	9.4	11.7	11.2	0.9	2.3	5.0	6.1	5/5	4/4	4/6	4	4	5
32496	RGC	4	7	29	5.5	11.0	13.5	20.0	7.4	4.2	10.5	0.8	2.2	3.5	4.4	6/7	7/7	4/5	6	7	5
32497	RGC	4	7	29	5.6	11.3	12.0	17.2	8.0	8.5	12.0	1.0	2.5	3.9	7.4	5/6	6/6	5/6	5	6	5
32499	RGC	4	1	4	6.0	12.0	18.0	23.0	8.0	11.0	18.0	0.9	1.9	5.0	6.8	7/6	4/3	5/4	5	4	3
35369	RGC	3	4	22	3.6	8.6	7.7	12.0	6.3	3.8	8.0	0.5	1.7	1.5	3.0	6/6	7/7	4/6	7	8	6
35370	RGC	4	8	33	5.4	10.0	16.5	22.5	7.1	8.9	12.0	0.7	2.0	3.7	7.7	6/5	6/7	4/5	6	7	4
35373	RGC	4	6	25	5.5	9.1	14.3	19.0	6.0	8.7	10.2	0.8	2.0	2.9	4.5	6/7	6/5	5/5	7	6	5
35374	RGC	4	7	25	5.0	11.0	14.4	18.8	8.9	8.9	14.0	1.0	2.3	4.0	5.8	5/5	5/5	4/4	5	6	4
35375	RGC	4	8	33	5.2	9.7	12.8	16.0	8.6	9.5	12.3	0.9	2.1	3.6	4.9	5/5	6/6	4/6	5	7	6
35376	RGC	4	4	17	4.2	9.2	9.2	18.0	7.4	6.8	15.0	0.5	1.7	2.4	6.0	7/5	7/7	5/6	7	8	5
35377	RGC	5	4	13	5.6	10.9	12.4	17.0	6.4	6.3	12.0	0.9	2.0	3.5	5.5	5/5	7/7	4/6	4	7	5
35378	RGC	4	5	21	4.2	7.7	12.5	15.0	6.0	6.4	14.0	0.5	1.7	2.6	5.0	5/5	7/7	4/4	7	7	4
35379	RGC	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35380	RGC	4	6	25	5.2	9.1	12.8	20.0	7.3	8.3	14.0	0.9	1.7	3.5	5.0	7/7	7/6	4/5	7	7	4

[1] = Numbered scale of 1 to 9 with a value of 1 being the most vigorous

Table 2 (cont'd). Performance Summary of Cottonwoods and Black Willows to the Four Treatments Combined for 1984-1987.

Accession	Species	Replications	No. of Plants	Percent Survival	Average Tree Height (ft)				Average Canopy Width (ft)			Average Caliper (inches)				Average Foliage Leaf Density & Branch Abundance[1]			Vigor[1]		
					1984	1985	1986	1987	1985	1986	1987	1984	1985	1986	1987	1985	1986	1987	1985	1986	1987
35381	RGC	4	7	29	6.1	11.1	13.4	20.0	7.1	8.3	10.0	0.4	2.3	3.3	4.0	6/6	6/6	4/5	5	7	4
35382	RGC	3	4	22	6.8	11.7	19.9	25.0	7.5	11.5	18.0	1.0	2.2	4.5	6.3	6/5	4/4	4/5	5	4	4
35383	RGC	4	7	25	5.3	10.3	16.9	20.0	7.7	10.1	12.0	0.8	2.2	3.9	6.8	6/6	5/5	4/5	6	5	4
35384	RGC	6	4	17	4.0	10.7	12.3	12.0	8.8	7.2	10.0	0.7	2.4	2.7	6.0	6/6	7/7	4/4	6	8	6
35385	RGC	4	3	13	4.3	9.3	8.4	22.0	8.2	5.9	16.3	0.5	2.0	2.5	7.6	6/6	8/8	4/6	6	8	5
35386	RGC	4	9	38	6.3	12.2	16.5	21.0	8.8	9.2	12.0	1.0	2.2	3.6	7.2	5/5	6/6	5/6	5	7	6
35388	RGC	4	4	17	6.5	12.1	14.3	26.0	9.4	8.3	17.0	0.8	2.3	3.5	5.9	6/5	7/8	5/5	5	8	4
35389	RGC	4	3	13	1.9	3.7	4.0	7.0	3.8	1.3	5.0	0.4	0.7	0.0	3.0	7/7	9/9	5/9	7	9	6
35390	RGC	4	0	0	5.5	4.5	0.0	0.0	3.0	0.0	0.0	0.3	0.8	0.0	0.0	8/8	0/0	0/0	8	0	0
35391	RGC	4	4	17	5.3	9.7	10.0	19.5	9.0	6.8	13.0	0.9	2.1	3.5	7.8	6/6	7/7	5/7	5	7	6
35395	RGC	4	19	79	6.6	13.3	18.5	28.0	6.1	8.0	13.5	0.7	2.1	4.9	9.6	7/6	6/7	4/4	4	6	3
45529	RGC	4	14	58	6.2	11.4	13.8	17.2	8.6	7.8	9.8	0.9	2.1	3.1	4.1	6/5	6/7	4/6	5	7	5
45530	RGC	6	15	42	5.9	12.3	15.7	24.0	8.5	8.5	14.0	0.9	2.3	3.7	8.0	5/5	5/5	3/3	4	5	4
45532	RGC	4	14	58	6.0	10.3	14.0	24.0	7.6	8.5	12.0	1.0	2.3	4.0	8.4	5/5	6/5	4/4	5	6	3
45534	RGC	4	10	42	5.7	10.4	14.5	20.0	9.1	10.0	13.0	0.9	2.2	3.7	7.0	5/5	5/5	4/4	4	5	5

[1] = Numbered scale of 1 to 9 with a value of 1 being the most vigorous

Table 3. Performance of Cottonwoods and Black Willows presoaked 10 to 14 days prior to planting for 1984-1987.

			Live Plants		Average Tree Height				Average Canopy Width			Average Stem Width Measured at Ground Level				Average Foliage Leaf Density & Branch Abundance [1]			Vigor [1]		
Accession	Species	Replications	1987	Percent Survival	1984	1985	1986	1987	1985	1986	1987	1984	1985	1986	1987	1985	1986	1987	1985	1986	1987
45533	W	A	6	100	3.7	5.6	6.7	7.0	4.0	4.5	5.0	0.4	0.8	1.5	5.0	6/7	8/8	4/4	7	8	6
	W	B	6	100	3.8	6.0	7.3	8.0	5.7	7.1	10.0	0.4	1.0	1.0	4.3	6/5	6/7	4/4	5	6	4
32491	W	A	4	66	7.3	13.0	12.0	16.0	8.4	7.5	9.0	0.4	1.4	1.8	3.5	6/5	5/6	5/5	2	6	4
	W	B	4	66	4.2	9.9	13.9	11.0	7.2	5.1	7.0	0.4	1.3	1.5	6.0	5/5	6/7	4/7	5	6	6
35372	W	A	5	83	7.6	14.4	10.1	18.0	8.3	5.6	7.0	0.4	1.6	1.4	7.7	6/5	7/7	4/5	4	7	4
	W	B	5	83	6.1	12.2	11.2	10.0	7.8	5.2	7.0	0.7	1.7	0.9	4.7	4/4	8/8	6/7	3	8	7
45531	W	A	5	83	7.1	12.0	11.9	17.5	6.3	6.6	7.0	0.4	1.5	2.0	5.0	4/5	6/6	5/5	2	6	5
	W	B	5	83	4.2	7.7	8.1	15.0	6.5	8.0	10.0	0.4	1.2	1.5	3.3	5/5	7/7	4/7	4	7	5
32493	W	A	3	50	2.7	3.5	5.8	6.0	6.8	7.5	7.5	0.5	0.7	-	1.8	5/5	8/8	5/7	7	7	7
	W	B	6	100	3.5	6.7	8.7	14.0	5.4	7.0	9.0	0.4	1.2	-	6.0	6/5	6/6	3/4	6	6	4
35371	W	A	3	50	4.7	7.8	13.0	15.0	5.6	7.3	8.0	0.3	1.2	2.6	8.0	5/6	5/5	4/3	5	5	4
	W	B	2	33	2.9	7.9	8.3	12.0	7.8	7.5	10.0	0.4	1.2	1.3	3.5	5/5	4/5	4/5	5	5	5
35381	RGC	A	4	66	7.5	13.4	11.5	18.0	7.4	8.0	7.3	0.6	2.5	3.0	3.0	6/5	7/7	5/6	3	8	5
	RGC	B	3	50	4.7	8.8	15.3	21.0	6.8	8.5	12.0	0.5	2.0	3.5	5.0	6/6	5/5	4/4	7	5	4
45529	RGC	A	5	83	6.6	13.3	18.5	26.0	6.1	8.0	11.0	0.7	2.1	4.9	4.9	7/6	6/7	5/4	4	6	3
	RGC	B	5	83	6.2	11.3	9.5	22.0	8.6	5.2	9.0	0.7	1.5	1.1	6.0	5/5	7/8	4/6	5	8	7
32492	RGC	A	5	83	5.7	10.4	16.2	22.0	6.0	9.6	14.0	0.7	2.1	3.7	5.8	6/6	5/5	3/3	5	5	3
	RGC	B	3	50	8.2	15.5	12.8	30.0	8.5	8.3	10.0	1.2	2.6	2.7	10.0	4/4	2/3	4/4	2	2	4
45530	RGC	A	5	83	7.7	14.4	15.7	28.0	7.6	10.4	12.0	0.9	2.3	3.1	7.0	5/5	4/4	4/4	3	3	4
	RGC	B	3	50	4.1	9.8	18.2	21.0	7.2	10.3	15.0	0.5	1.9	3.7	8.0	6/6	4/4	3/3	6	4	3
35395	RGC	A	5	83	9.0	16.0	16.6	27.0	7.7	9.3	10.0	1.5	3.1	3.3	10.0	4/4	3/3	4/4	1	3	3
	RGC	B	5	83	7.9	16.4	23.3	35.0	7.4	9.2	13.0	1.1	2.6	6.5	10.0	4/4	2/3	4/4	2	2	4
35389	RGC	A	0	0	1.1	1.5	-	-	4.5	-	-	0.2	1.5	-	-	8/8	-	-	8		-
	RGC	B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35370	RGC	A	5	83	5.3	9.2	17.0	23.0	5.5	10.4	13.0	0.6	2.0	4.1	4.3	6/5	6/7	4/3	6	7	3
	RGC	B	2	33	5.4	10.8	16.0	22.0	8.7	7.3	11.0	0.7	2.0	3.3	11.0	5/5	6/6	3/6	5	7	4
45532	RGC	A	5	83	8.3	12.1	15.0	25.0	6.7	10.2	13.0	1.1	2.4	5.3	10.0	3/4	4/4	4/4	3	4	3
	RGC	B	4	67	6.3	10.4	13.4	22.0	6.3	9.8	12.0	0.9	2.5	3.8	6.7	6/6	7/7	3/3	5	7	3
32497	RGC	A	5	83	6.2	11.8	11.9	24.0	7.2	10.4	15.0	0.8	2.5	4.5	10.0	4/4	4/4	4/3	3	4	3
	RGC	B	2	33	6.1	10.7	12.0	15.0	8.8	6.5	9.0	1.1	2.5	3.3	4.5	6/7	8/8	7/9	7	8	8
32495	RGC	A	1	17	2.7	7.0	2.5	5.0	4.8	1.5	4.0	0.2	1.2	1.5	1.5	6/5	9/9	5/5	6	9	5
	RGC	B	2	33	4.7	10.6	12.0	17.0	9.3	8.5	12.0	0.4	1.5	1.5	6.5	4/5	5/5	3/3	4	5	4

[1] = Numerical scale of 1 to 9 with a value of 1 being the most vigorous.

...seedlings presoaked for 12 to 14 days prior to planting for 1984-1987.

			Live Plants		Average Tree Height				Average Canopy Width			Average Stem Width Measured at Ground Level				Average Foliage Leaf Density & Branch Abundance[1]			Vigor[1]		
Accession	Species	Replications	1987	Percent Survival	1984	1985	1986	1987	1985	1986	1987	1984	1985	1986	1987	1985	1986	1987	1985	1986	1987
35382	RGC	A	2	33	7.6	12.8	22.0	26.0	7.8	13.0	18.0	1.1	2.2	4.5	7.0	7/5	3/4	4/5	5	3	4
	RGC	B	3	50	5.9	10.6	17.7	24.0	7.2	9.33	18.0	0.9	2.2	4.5	5.5	5/5	4/4	3/4	5	5	4
35373	RGC	A	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	RGC	B	3	50	5.8	10.6	17.2	23.0	5.5	9.3	11.3	0.7	2.1	3.5	6.0	6/6	5/4	4/6	6	5	5
35380	RGC	A	2	33	4.7	6.3	11.5	15.0	6.8	9.0	13.0	0.9	1.3	2.5	4.8	7/7	7/6	5/5	7	7	5
	RGC	B	4	66	5.7	11.9	14.1	24.0	7.8	7.5	14.0	0.9	2.1	4.5	5.3	6/7	6/6	4/5	6	7	4
35369	RGC	A	2	33	3.8	9.3	7.8	12.0	7.2	5.5	8.0	0.4	1.8	1.5	3.0	6/7	8/7	4/6	7	8	6
	RGC	B	0	0	2.7	-	-	-	0.4	-	-	-	-	-	-	-	-	-	-	-	-
35376	RGC	A	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	RGC	B	1	17	4.9	10.3	13.0	20.0	7.0	6.5	15.0	0.4	1.8	2.8	4.0	7/5	7/7	5/5	6	8	5
35379	RGC	A	1	17	4.5	8.3	17.5	20.0	6.5	8.0	13.0	0.5	2.0	3.0	7.0	5/6	4/4	5/5	6	5	5
	RGC	B	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35378	RGC	A	2	33	5.7	9.0	11.5	15.0	6.4	6.3	14.0	0.7	1.9	2.2	5.0	5/5	8/7	4/4	6	7	5
	RGC	B	1	17	2.6	6.3	13.5	15.0	5.6	6.5	14.0	0.3	1.5	3.0	5.0	5/5	6/6	4/4	7	7	4
35388	RGC	A	0	0	6.0	11.3	12.0	-	10.2	7.5	-	0.9	2.4	3.0	-	5/5	8/8	-	4	9	-
	RGC	B	1	17	6.9	12.8	16.5	26.0	8.5	9.0	17.0	0.7	2.1	4.0	5.9	6/5	6/7	5/5	5	7	4
35385	RGC	A	2	33	3.6	7.9	11.3	17.0	7.3	9.3	12.5	0.4	2.0	2.5	4.0	6/6	7/7	4/7	6	6	6
	RGC	B	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
32499	RGC	A	1	17	6.0	12.0	18.0	23.0	8.0	11.0	18.0	0.9	1.9	5.0	6.8	7/6	4/3	5/4	5	4	3
	RGC	B	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35383	RGC	A	3	50	7.0	12.5	20.3	24.0	7.3	14.7	15.0	0.6	2.5	6.5	9.0	5/6	3/4	3/4	4	3	3
	RGC	B	1	17	4.8	10.0	20.0	22.0	7.5	9.0	15.0	0.4	1.9	4.0	6.0	6/6	4/5	4/4	7	5	5
35391	RGC	A	1	17	5.6	11.0	17.0	24.0	10.0	14.0	18.0	0.7	2.1	6.0	11.0	5/6	4/5	3/4	5	4	4
	RGC	B	2	33	5.5	8.5	6.0	15.0	7.0	3.32	8.0	1.1	2.0	1.0	4.5	6/6	8/8	7/9	6	8	8
35390	RGC	A	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	RGC	B	-	0	5.5	4.5	-	-	3.0	0	-	0.3	0.8	0	-	8/8	-	-	8	-	-
35386	RGC	A	0	0	6.3	12.7	14.8	-	5.7	9.5	-	0.8	2.1	4.0	-	5/5	6/7	-	4	8	-
	RGC	B	2	33	5.7	11.1	18.8	26.0	7.1	8.8	10.0	0.9	2.1	4.0	7.3	6/6	5/5	4/7	6	6	6
32496	RGC	A	1	17	4.1	9.5	9.5	14.0	6.5	7.0	10.0	0.8	2.1	3.5	4.0	7/6	8/7	5/6	6	8	6
	RGC	B	3	50	5.6	11.5	19.0	26.0	5.9	7.0	11.0	0.5	2.3	3.5	4.8	7/6	5/5	4/4	7	5	4
35375	RGC	A	1	17	4.0	9.0	12.0	15.0	8.0	10.0	15.0	0.5	1.9	4.0	5.5	6.4	7/8	2/3	6	7	7
	RGC	B	3	50	6.4	11.5	17.8	26.0	8.0	12.0	12.0	0.9	2.2	5.7	6.0	5/5	6/6	4/5	4	5	5
32490	RGC	A	1	17	6.3	12.0	17.0	24.0	12.0	16.0	18.0	1.0	2.2	6.0	11.5	4/4	5/5	3/3	3	4	3
	RGC	B	3	50	6.0	10.5	17.7	23.0	5.7	10.3	15.0	0.8	2.2	4.5	5.0	6/5	4/5	3/3	5	5	3

[1] = Numerical scale of 1 to 9 with a value of 1 being the most vigorous.

			Live Plants		Average Tree Height				Average Canopy Width			Average Stem Width Measured at Ground Level				Average Foliage Leaf Density & Branch Abundance[1]			Vigor[1]		
Accession	Species	Replications	1987	Percent Survival	1984	1985	1986	1987	1985	1986	1987	1984	1985	1986	1987	1985	1986	1987	1985	1986	1987
32494	RGC	A	3	50	7.6	12.2	17.2	24.0	8.5	12.7	16.0	0.8	2.2	6.2	11.0	4/4	4/4	4/3	4	4	3
	RGC	B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35384	RGC	A	1	17	2.0	9.0	11.5	8.0	10.0	8.0	9.0	0.2	2.2	3.0	4.2	6/6	7/8	4/4	6	8	7
	RGC	B	0	0	5.5	14.0	15.5	-	7.0	8.0	-	0.9	2.4	3.5	-	7/7	7/7	-	6	7	-
45534	RGC	A	2	33	6.6	10.8	12.5	18.0	8.3	9.0	14.0	0.9	2.6	4.0	4.0	4/5	7/8	5/6	5	8	6
	RGC	B	4	66	6.2	11.6	15.3	26.0	7.7	9.5	13.0	0.9	2.3	2.9	7.0	6/5	5/5	4/4	5	5	5
35374	RGC	A	1	17	6.2	11.0	13.0	20.0	10.0	12.0	22.0	0.8	2.4	5.0	6.0	6/5	5/6	4/4	5	6	4
	RGC	B	1	17	5.0	11.0	15.5	20.0	7.5	5.0	11.0	0.5	1.9	4.5	4.5	5/5	7/7	4/5	6	7	4
35377	RGC	A	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	RGC	B	1	17	6.4	12.5	10.8	17.0	8.2	5.5	12.0	1.0	2.1	3.5	5.5	5/5	8/8	4/6	4	8	5

[1] = Numerical scale of 1 to 9 with a value of 1 being the most vigorous.

Species: W = Black willow
RGC = Rio Grande cottonwoods

Table 4. Performance data of Cottonwoods and Black Willows receiving 17 days of mist prior to planting for 1984-1987 .

			Live Plants		Average Tree Height				Average Canopy Width			Average Stem Diam. Measured at Ground Level				Average Foliage Leaf Density & Branch Abundance			Vigor[1]		
Accession	Species	Replications	1987	Percent Survival	1984	1985	1986	1987	1985	1986	1987	1984	1985	1986	1987	1985	1986	1987	1985	1986	1987
32491	W	A	0	0	4.8	9.5	7.0	-	10.0	3.0	-	0.8	2.3	-	-	6/5	9/8	-	5	9	-
	W	B	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
32494	RGC	A	5	83	7.8	13.8	17.1	21.0	8.8	12.3	13.0	0.9	2.5	4.8	9.4	6/5	5/5	4/6	4	5	4
	RGC	B	1	17	5.0	9.3	15.0	18.0	11.0	10.0	13.0	0.8	-	-	-	-	-	-	-	-	-
35395	RGC	A	3	50	6.7	10.1	17.2	22.0	6.3	8.3	12.0	1.1	2.8	4.7	6.0	4/5	4/4	4/5	4	4	4
	RGC	B	4	66	7.9	15.7	22.1	26.0	10.0	13.0	19.0	1.9	3.0	8.0	12.2	4/4	2/1	2/2	3	1	2
45530	RGC	A	1	17	7.5	15.0	16.0	22.5	9.9	8.5	15.0	1.6	3.0	4.5	7.5	5/4	4/4	3/3	3	4	4
	RGC	B	5	83	5.5	11.6	16.9	24.0	8.5	9.4	12.0	1.1	2.3	4.0	7.5	5/5	5/4	3/3	4	4	3
45534	RGC	A	3	50	5.6	10.5	16.7	19.0	8.3	8.8	7.4	0.8	2.0	4.0	7.4	5/5	4/4	5/4	4	3	4
35385	RGC	A	1	17	5.0	10.6	5.5	26.0	9.0	-	20.0	0.5	2.0	2.5	11.2	6/5	8/9	4/5	6	9	4
	RGC	B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35369	RGC	A	0	0	4.2	7.8	7.5	-	5.3	6.0	-	0.8	1.5	1.5	-	6/5	6/7	-	7	7	-
	RGC	B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
45532	RGC	A	2	33	5.8	11.1	17.8	24.0	10.5	9.3	15.0	1.1	2.3	5.0	10.5	6/5	5/4	5/4	5	5	4
	RGC	B	2	33	3.7	7.7	9.8	13.0	7.0	4.5	10.0	0.7	1.8	1.8	2.5	6/5	6/6	5/6	6	7	6
32492	RGC	B	1	17	5.3	9.0	14.0	20.0	10.0	11.5	18.0	0.9	2.1	3.5	10.0	6/5	5/4	7/4	6	5	4
	RGC	B	4	66	5.0	10.4	16.3	18.0	7.5	8.4	7.5	1.1	2.3	4.1	6.6	4/5	4/4	4/5	4	4	4
32499	RGC	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	RGC	B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
45529	RGC	A	1	17	5.8	10.5	12.0	11.0	11.0	7.0	8.0	1.1	2.5	3.0	2.2	5/5	7/8	5/7	5	9	7
	RGC	B	2	33	6.0	10.5	15.3	19.0	8.6	11.0	15.0	1.1	2.2	3.3	6.4	5/5	3/4	4/5	5	4	4
35386	RGC	A	1	17	7.4	15.0	17.2	21.0	10.3	9.8	13.0	1.4	2.7	3.8	6.7	3/4	7/7	5/5	2	8	6
	RGC	B	1	17	5.9	10.0	15.0	16.0	10.0	8.5	13.0	0.9	1.7	2.5	7.5	5/5	5/5	5/6	6	5	5
35383	RGC	B	1	17	4.0	9.2	13.5	18.0	8.2	7.5	10.0	0.9	2.3	2.0	6.6	6/5	7/7	6/7	6	7	5
	RGC	B	2	33	5.4	9.4	13.8	19.0	7.7	9.3	10.0	1.1	2.0	3.0	6.6	6/5	5/4	6/7	6	5	5
35375	RGC	A	3	50	5.7	10.2	9.8	11.0	9.4	5.8	10.0	0.9	2.1	1.7	4.3	5/5	7/7	4/8	4	7	7
	RGC	B	1	17	4.8	8.0	10.5	12.0	9.0	10.0	12.0	1.1	2.0	3.0	4.9	5/5	4/4	4/7	6	7	5
35374	RGC	A	1	17	6.0	12.5	13.0	15.0	10.0	8.0	13.0	1.3	2.5	2.0	5.8	5/5	6/5	4/4	5	6	5
	RGC	B	4	66	5.9	9.4	16.0	20.0	8.2	10.0	10.0	1.2	2.4	4.3	7.0	5/5	3/3	3/3	5	3	4
35389	RGC	A	1	17	2.7	5.3	5.0	7.0	3.6	2.0	5.0	0.8	0.9	-	3.0	6/6	9/9	5/9	5	3	4
	RGC	B	0	0	2.0	4.4	3.0	-	3.3	0.5	-	0.3	0.9	-	-	6/7	9/9	-	7	9	-

[1] = Numerical scale of 1 to 9 with a value of 1 being the most vigorous

Table 4 (cont'd). Performance data of Cottonwoods and Black Willows receiving 17 days of mist prior to planting for 1984-1987.

			Live Plants		Average Tree Height				Average Canopy Width			Average Stem Diam. Measured at Ground Level				Average Foliage Leaf Density & Branch Abundance			Vigor[1]		
Accession	Species	Replications	1987	Percent Survival	1984	1985	1986	1987	1985	1986	1987	1984	1985	1986	1987	1985	1986	1987	1985	1986	1987
32496	RGC	A	0	0	6.7	12.0	12.0	-	9.7	5.0	-	1.0	2.3	3.5	-	5/5	8/8	-	5	7	-
35379	RGC	A	1	17	3.5	8.1	5.3	15.0	7.8	7.0	15.0	0.6	1.6	2.0	9.0	6/5	7/7	5/7	7	7	5
	RGC	B	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35384	RGC	A	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	RGC	B	1	17	4.6	9.0	9.8	17.0	9.5	5.5	12.0	1.0	2.7	1.5	8.0	5/5	8/7	5/5	6	9	5
32490	RGC	A	1	17	3.5	5.3	9.5	16.0	4.9	4.5	10.0	0.6	1.3	1.5	3.3	7/6	8/7	5/6	7	8	5
	RGC	B	3	50	4.7	8.5	13.5	15.0	7.7	9.2	13.0	1.0	2.2	3.5	4.7	5/6	4/4	3/3	5	5	4
35373	RGC	A	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	RGC	B	3	50	5.1	7.6	11.3	15.0	6.4	8.0	9.0	0.8	1.9	2.3	3.0	6/7	6/6	5/4	7	6	5
35382	RGC	A	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	RGC	B	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

[1] = Numerical scale of 1 to 9 with a value of 1 being the most vigorous

W = Black Willows
RGC = Rio Grande cottonwoods

Table 5. Performance data of cottonwoods and black willows receiving 28 days of mist prior to planting for 1984-1987.

			Live Plants		Average Tree Height				Average Canopy Width			Average Stem Diam. Measured at Ground Level				Average Foliage Leaf Density & Branch Abundance			Vigor[1]		
Accession	Species	Replications	1987	Percent Survival	1984	1985	1986	1987	1985	1986	1987	1984	1985	1986	1987	1985	1986	1987	1985	1986	1987
35372	W	A	6	100	6.1	11.9	16.8	20.0	6.9	8.3	8.0	0.9	1.8	3.3	5.0	4/4	2/2	2/2	1	1	2
	W	B	2	33	3.2	5.6	10.0	10.0	4.9	5.5	7.5	0.4	1.0	0.8	2.0	5/5	7/7	3/3	5	7	4
45531	W	A	2	33	3.1	7.1	11.5	15.0	7.1	6.5	10.0	0.5	1.2	1.3	2.8	5/5	6/5	5/5	5	6	5
	W	B	3	50	3.6	8.4	11.7	18.0	11.0	8.0	14.0	0.4	1.2	1.5	3.8	5/4	3/3	3/3	2	4	4
45533	W	A	2	33	1.8	3.7	5.0	6.0	7.6	4.8	11.0	0.3	0.9	-	2.8	5/5	8/8	4/5	5	8	7
	W	B	3	50	3.0	5.2	5.2	8.0	10.9	4.8	8.0	0.4	0.9	-	3.0	5/5	6/6	4/5	5	6	5
32491	W	A	1	17	3.6	6.9	9.0	9.0	6.0	6.0	6.0	0.4	0.8	1.0	2.5	6/5	7/6	5/7	5	6	6
	W	B	2	33	2.1	5.6	7.8	13.0	4.1	4.3	8.0	0.4	0.6	1.5	2.2	5/5	6/6	5/4	5	6	5
32493	W	A	1	17	1.8	5.5	6.0	6.0	10.0	4.5	4.0	0.3	1.2	0.5	3.0	5/5	8/8	7/5	5	8	7
	W	B	0	0	2.3	4.9	4.3	-	3.7	2.5	-	0.4	0.6	-	-	5/5	9/9	-/	6	9	-
32495	W	A	0	0	2.4	4.8	-	-	5.3	-	-	0.5	0.9	-	-	5/5	-	-	6	-	-
	W	B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35371	W	A	1	17	4.0	7.2	8.0	14.0	7.6	5.5	13.0	0.4	0.8	1.0	6.0	6/5	6/7	3/4	4	7	4
	W	B	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35370	RGC	A	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	RGC	B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35385	RGC	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	RGC	B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35377	RGC	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	RGC	B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
32497	RGC	A	-	-	4.6	-	-	-	-	-	-	-	1.2	-	-	-	-	-	-	-	-
	RGC	B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35384	RGC	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	RGC	B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35388	RGC	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	RGC	B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35378	RGC	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	RGC	B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35380	RGC	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	RGC	B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
32496	RGC	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	RGC	B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

[1] = Numerical scale of 1 to 9 with a value of 1 being the most vigorous

Table 5 (cont'd). Performance data of Cottonwoods and Black Willows receiving 28 days of mist prior to planting for 1984-1987.

			Live Plants		Average Tree Height				Average Canopy Width			Average Stem Diam. Measured at Ground Level				Average Foliage Leaf Density & Branch Abundance			Vigor[1]		
Accession	Species	Replications	1987	Percent Survival	1984	1985	1986	1987	1985	1986	1987	1984	1985	1986	1987	1985	1986	1987	1985	1986	1987
35379	RGC	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	RGC	B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35381	RGC	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	RGC	B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35377	RGC	A	-	-	4.5	9.3	14.0	-	4.5	7.0	-	0.8	1.9	3.5	-	5/5	5/5	-	4	5	-
	RGC	B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35390	RGC	A	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	RGC	B	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
45530	RGC	A	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
45534	RGC	A	1	17	4.3	8.5	13.5	18.0	10.2	12.5	19.0	0.8	2.0	4.0	8.2	4/4	3/2	3/3	3	3	4
35376	RGC	A	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	RGC	B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35390	RGC	A	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	RGC	B	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

[1] = Numerical scale of 1 to 9 with a value of 1 being the most vigorous
W = Black Willows
RGC = Rio Grande cottonwoods

Table 6. Performance data of Cottonwoods and Black Willows directly planted into sprinkler irrigated system with no prior treatment for 1985-1987.

			Live Plants		Average Tree Height (feet)		Average Canopy Width		Average Stem Diameter (inches)		Average Leaf & Branch Density		Vigor [1]	
Accession	Species	Replications	1987	Percent Survival	1985	1987	1985	1987	1985	1987	1985	1987	1985	1987
45531	W	A	0	0	5.3	-	4.2	-	0.5	-	6/7	-	6	-
	W	B	3	50	6.0	6.0	4.9	6.0	0.6	2.0	5/5	6/7	4	6
45533	W	A	1	17	3.5	9.0	3.5	-	0.4	2.0	6/5	6/6	6	6
	W	B	0	0	2.3	-	2.5	-	0.2	-	6/6	-	6	-
35372	W	A	1	17	2.8	10.0	1.6	7.0	0.2	2.0	9/9	5/7	9	6
	W	B	0	0	-	-	-	-	-	-	-	-	-	-
35387	RGC	A	0	0	2.5	-	2.3	-	0.3	-	5/6	-	6	-
	RGC	B	0	0	-	-	-	-	-	-	-	-	-	-
35383	RGC	A	3	50	9.2	17.0	7.5	11.0	1.4	5.7	4/4	3/3	2	3
	RGC	B	0	0	-	-	-	-	-	-	-	-	-	-
35377	RGC	A	5	83	6.9	14.0	5.4	8.0	1.0	4.1	6/5	4/4	4	4
	RGC	B	0	0	-	-	-	-	-	-	-	-	-	-
35386	RGC	A	2	33	7.5	16.0	6.6	8.0	1.5	5.0	5/5	4/5	4	4
	RGC	B	3	50	6.8	8.5	4.5	6.5	1.0	3.0	6/6	5/8	5	6
45534	RGC	A	3	50	7.6	14.0	4.6	7.0	1.1	2.3	7/7	4/7	6	5
	RGC	B	2	33	5.8	10.0	4.5	6.0	0.9	2.0	5/6	5/5	6	6
35378	RGC	A	2	33	4.0	9.0	4.3	5.0	0.6	1.8	6/6	5/8	6	6
	RGC	B	0	0	-	-	-	-	-	-	-	-	-	-
35385	RGC	A	1	17	4.3	8.0	4.1	5.0	0.6	1.5	6/5	6/8	6	7
	RGC	B	0	0	-	-	-	-	-	-	-	-	-	-
35390	RGC	A	0	0	-	-	-	-	-	-	-	-	-	-
	RGC	B	0	0	-	-	-	-	-	-	-	-	-	-
35385	RGC	A	2	33	4.1	8.0	4.5	4.5	0.6	1.5	6/5	6/8	5	7
	RGC	B	0	0	-	-	-	-	-	-	-	-	-	-
32496	RGC	A	3	50	7.1	10.0	4.9	8.0	1.2	3.8	4/5	4/5	4	5
	RGC	B	0	0	-	-	-	-	-	-	-	-	-	-
32492	RGC	A	4	66	5.6	13.0	4.6	6.0	1.0	2.5	6/5	5/6	5	5
	RGC	B	0	0	-	-	-	-	-	-	-	-	-	-
35379	RGC	A	1	17	7.0	7.0	5.7	4.0	1.1	2.0	5/5	5/7	5	7
	RGC	B	0	0	-	-	-	-	-	-	-	-	-	-
35382	RGC	A	2	33	6.7	15.0	5.6	8.0	1.2	4.5	5/6	-	5	-
	RGC	B	0	0	-	-	-	-	-	-	-	-	-	-

[1] = Numerical scale of 1 to 9 with a value of 1 being the most vigorous

Table 6 (cont'd). Performance data of Cottonwoods and Black Willows directly planted into sprinkler irrigated system with no prior treatment for 1985-1987.

			Live Plants		Average Tree Height (feet)		Average Canopy Width		Average Stem Diameter (inches)		Average Leaf & Branch Density		Vigor[1]	
Accession	Species	Replications	1987	Percent Survival	1985	1987	1985	1987	1985	1987	1985	1987	1985	1987
45529	RGC	A	1	17	4.1	8.0	3.3	6.0	0.6	1.0	7/7	5/8	6	6
	RGC	B	0	0	-	-	-	-	-	-	-	-	-	-
32498	RGC	A	2	33	3.9	10.0	3.3	5.0	1.0	1.5	6/5	5/7	6	6
	RGC	B	0	0	-	-	-	-	-	-	-	-	-	-
24496	RGC	A	0	0	-	-	-	-	-	-	-	-	-	-
	RGC	B	0	0	-	-	-	-	-	-	-	-	-	-
35873	RGC	A	0	0	4.4	-	3.9	-	0.7	-	7/7	-	7	-
	RGC	B	0	0	-	-	-	-	-	-	-	-	-	-
35389	RGC	A	0	0	-	-	-	-	-	-	-	-	-	-
	RGC	B	0	0	-	-	-	-	-	-	-	-	-	-
35370	RGC	A	0	0	5.0	-	3.8	-	1.0	-	6/6	-	7	-
	RGC	B	0	0	-	-	-	-	-	-	-	-	-	-
32492	RGC	A	0	0	4.9	-	4.5	-	0.7	-	7/7	-	7	-
	RGC	B	4	66	5.6	13.0	4.9	6.0	1.1	2.5	6/5	5/6	4	5
32497	RGC	A	1	17	10.5	12.5	9.3	12.0	3.0	7.7	5/4	3/5	2	3
	RGC	B	0	0	-	-	-	-	-	-	-	-	-	-
32494	RGC	A	3	50	6.0	15.0	5.5	6.0	0.8	1.3	6/6	6/7	5	6
	RGC	B	2	33	6.9	8.5	4.8	8.0	1.4	2.6	5/4	4/6	4	5

[1] = Numerical scale of 1 to 9 with a value of 1 being the most vigorous

Figure 3

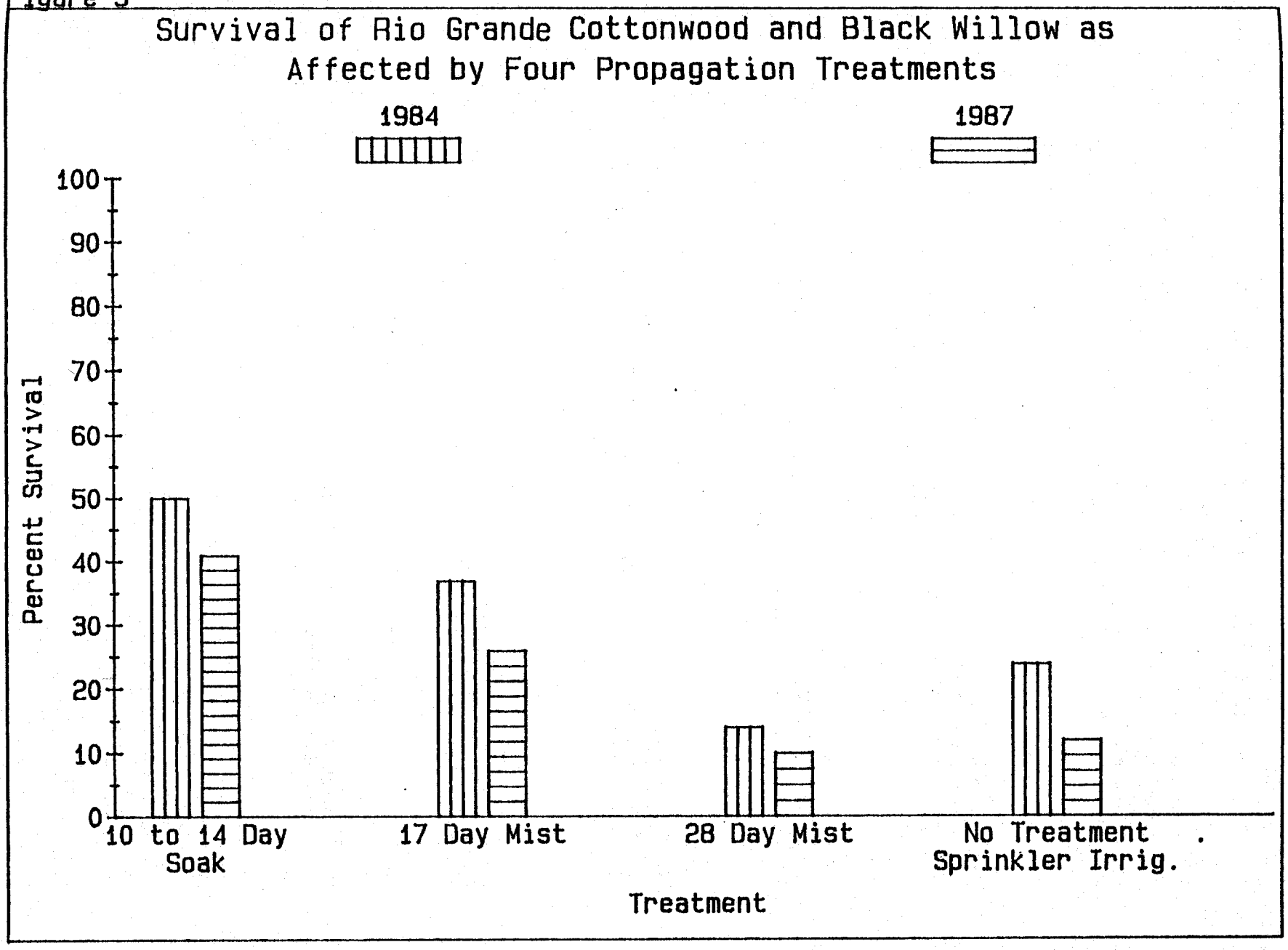

Survival of Rio Grande Cottonwood and Black Willow as Affected by Four Propagation Treatments
1984
1987
Percent Survival
100
90
80
70
60
50
40
30
20
10
0
10 to 14 Day Soak
17 Day Mist
28 Day Mist
No Treatment Sprinkler Irrig.
Treatment

Figure 4

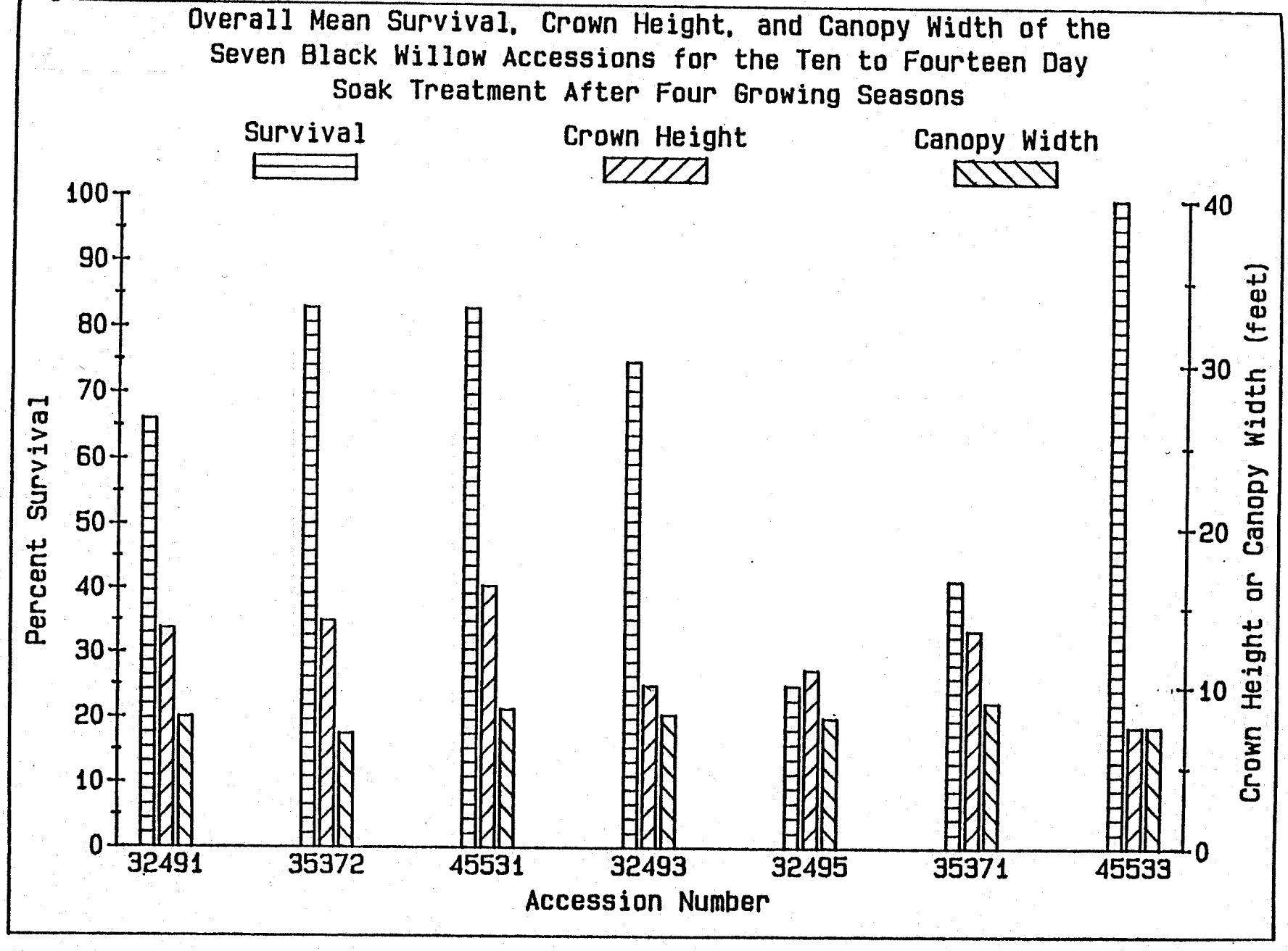

Overall Mean Survival, Crown Height, and Canopy Width of the Seven Black Willow Accessions for the Ten to Fourteen Day Soak Treatment After Four Growing Seasons
Survival
Crown Height
Canopy Width
Percent Survival
Crown Height or Canopy Width (feet)
100
90
80
70
60
50
40
30
20
10
0
40
30
20
10
0
32491
35372
45531
32493
32495
35371
45533
Accession Number

Figure 5

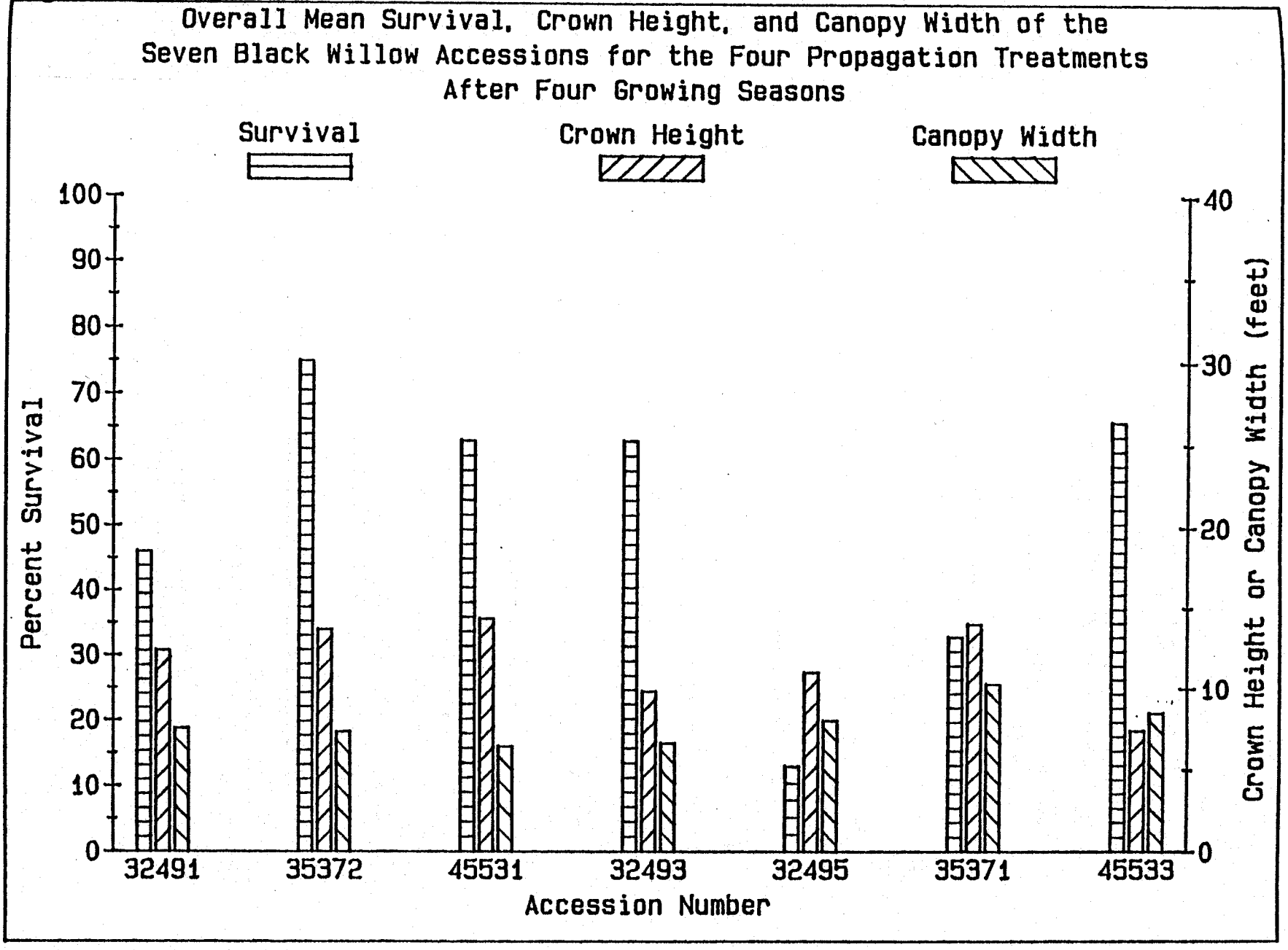

Overall Mean Survival, Crown Height, and Canopy Width of the
Seven Black Willow Accessions for the Four Propagation Treatments
After Four Growing Seasons
Survival
Crown Height
Canopy Width
Percent Survival
Crown Height or Canopy Width (feet)
100
90
80
70
60
50
40
30
20
10
0
40
30
20
10
0
32491
35372
45531
32493
32495
35371
45533
Accession Number

Figure 6A

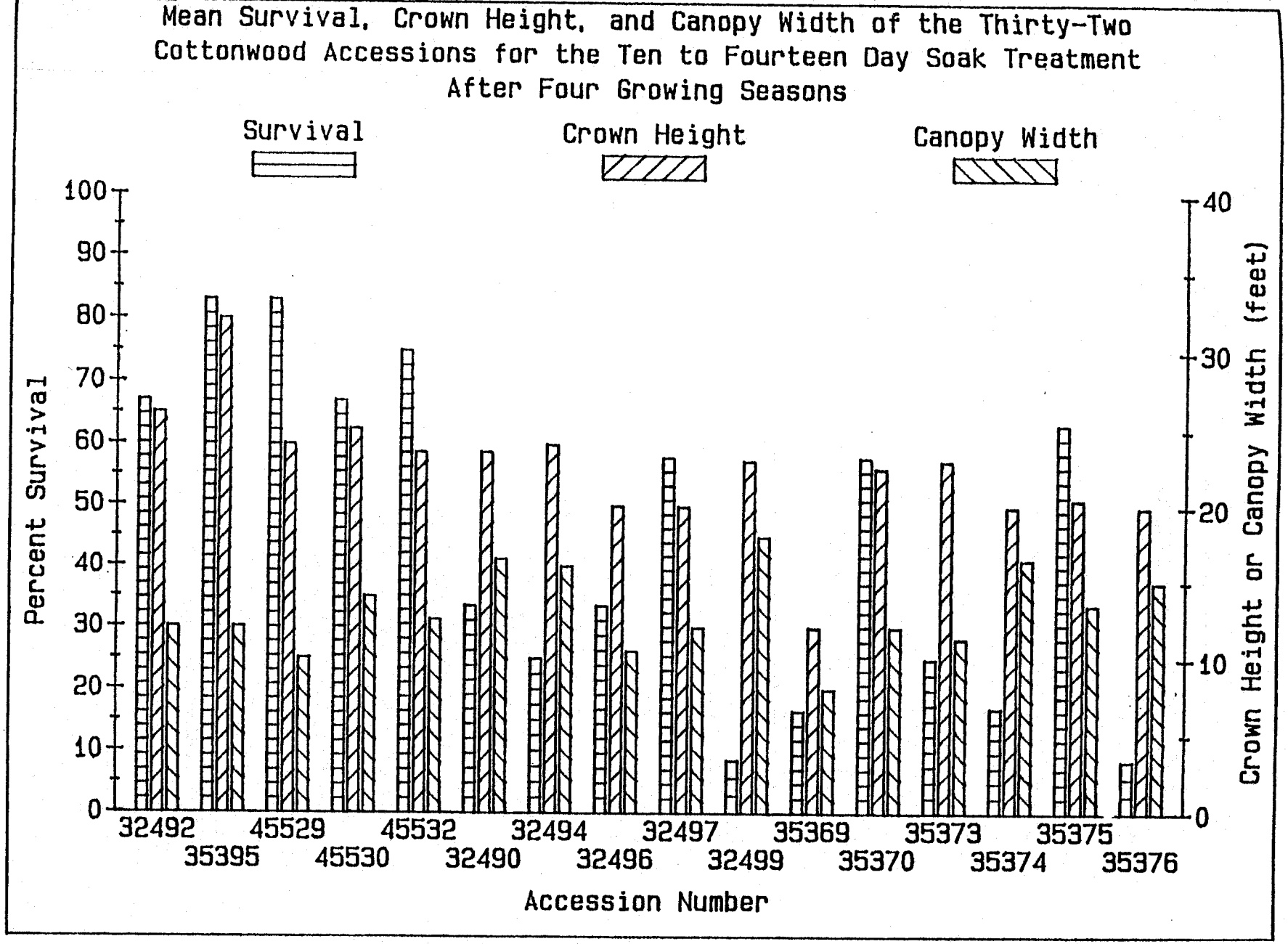

Mean Survival, Crown Height, and Canopy Width of the Thirty-Two Cottonwood Accessions for the Ten to Fourteen Day Soak Treatment After Four Growing Seasons
Survival
Crown Height
Canopy Width
Percent Survival
Crown Height or Canopy Width (feet)
100
90
80
70
60
50
40
30
20
10
0
40
30
20
10
0
32492
35395
45529
45530
45532
32490
32494
32496
32497
32499
35369
35370
35373
35374
35375
35376
Accession Number

Figure 6B

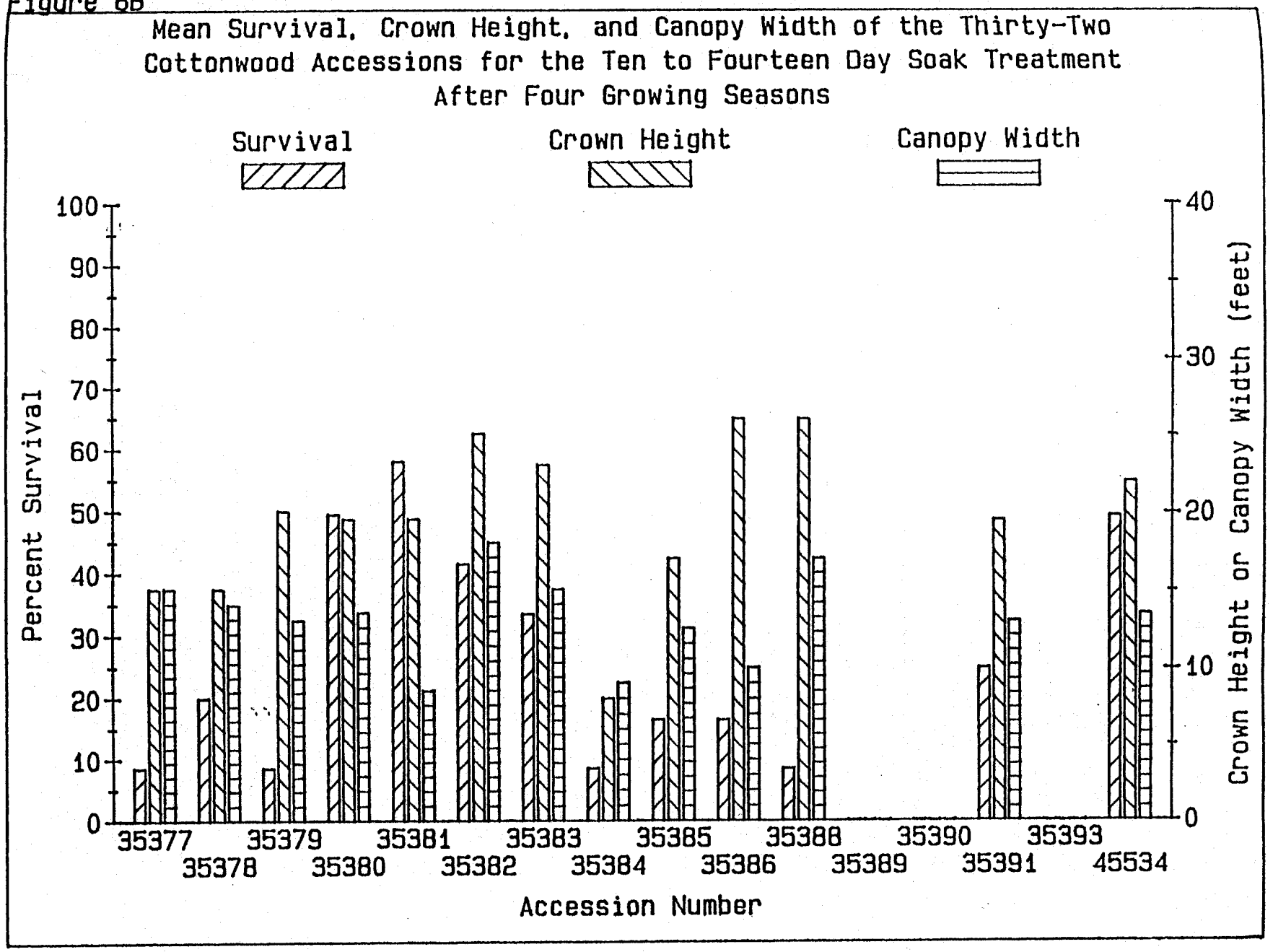

Mean Survival, Crown Height, and Canopy Width of the Thirty-Two
Cottonwood Accessions for the Ten to Fourteen Day Soak Treatment
After Four Growing Seasons
Survival
Crown Height
Canopy Width
Percent Survival
Crown Height or Canopy Width (feet)
0
10
20
30
40
50
60
70
80
90
100
0
10
20
30
40
35377
35378
35379
35380
35381
35382
35383
35384
35385
35386
35388
35389
35390
35391
35393
45534
Accession Number

Figure 7A

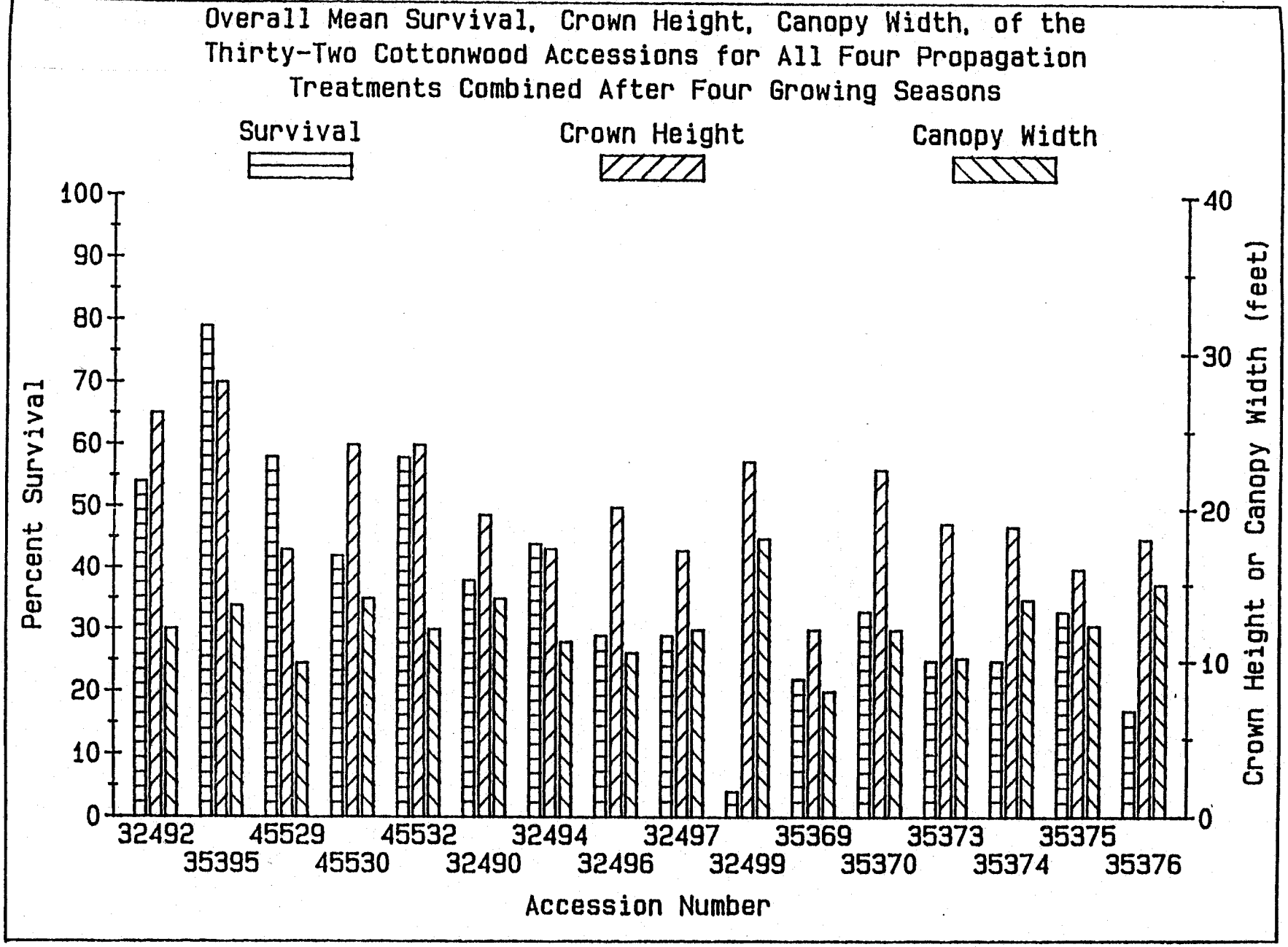
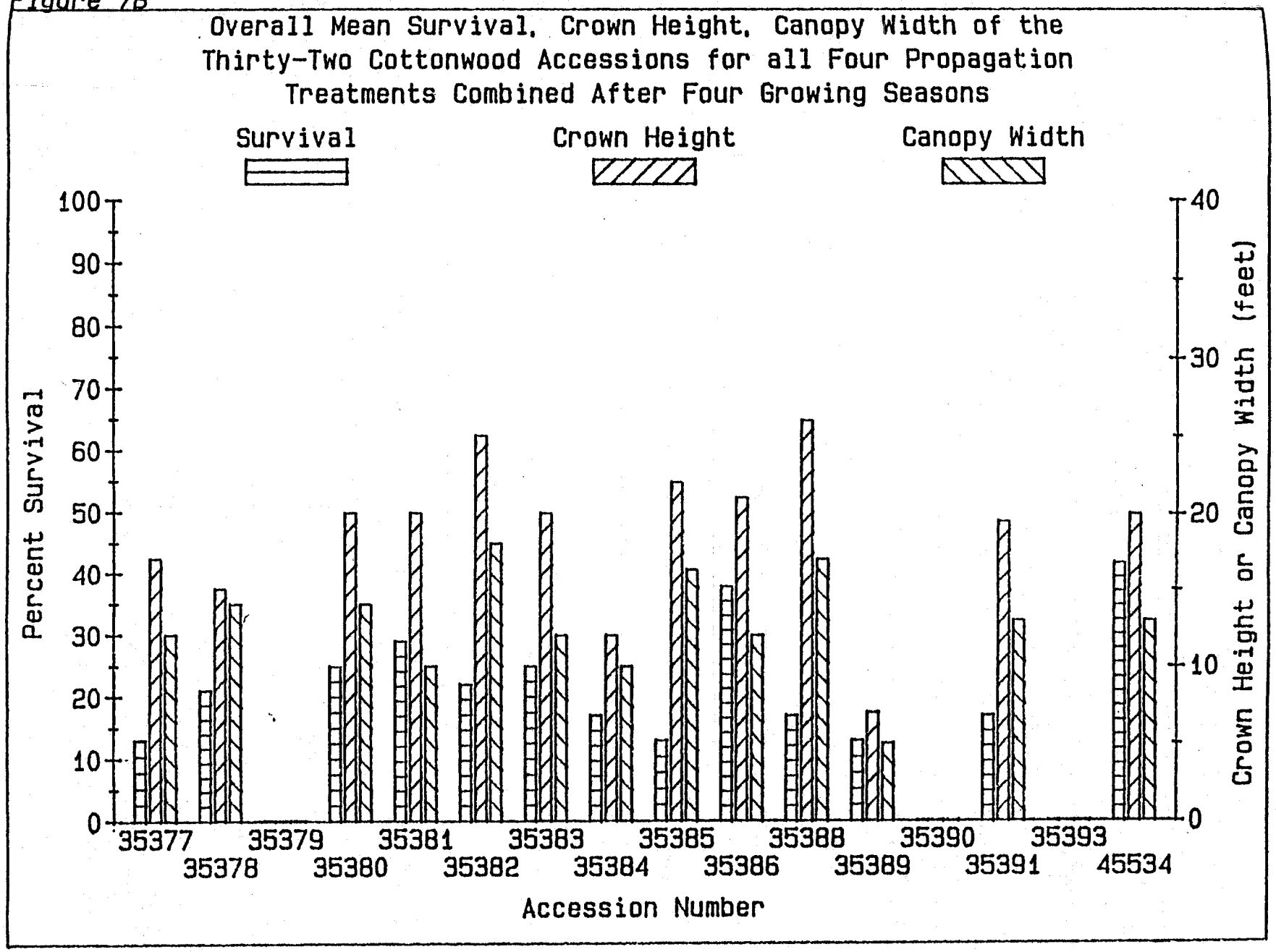

Overall Mean Survival, Crown Height, Canopy Width, of the Thirty-Two Cottonwood Accessions for All Four Propagation Treatments Combined After Four Growing Seasons
Survival
Crown Height
Canopy Width
Percent Survival
Crown Height or Canopy Width (feet)
100
90
80
70
60
50
40
30
20
10
0
40
30
20
10
0
32492
35395
45529
45530
45532
32490
32494
32496
32497
32499
35369
35370
35373
35374
35375
35376
Accession Number

Figure 7B


Overall Mean Survival, Crown Height, Canopy Width of the Thirty-Two Cottonwood Accessions for all Four Propagation Treatments Combined After Four Growing Seasons
Survival
Crown Height
Canopy Width
Percent Survival
Crown Height or Canopy Width (feet)
100
90
80
70
60
50
40
30
20
10
0
40
30
20
10
0
35377
35378
35379
35380
35381
35382
35383
35384
35385
35386
35388
35389
35390
35391
35393
45534
Accession Number

PERFORMANCE EVALUATION OF HYBRID POPLAR STRAINS (1983-87)

METHODS:

Hybrid poplars have been purchased from George Zappatinni, Inc., Sonora California, since 1983. Zappatinni is our only known available source for pole cuttings. During the past four years, we have purchased a total of 7 hybrid strains, all recommended as being superior performers by Zappatinni. The 7 strains were Jacometti, Incrassata, Caudina, 2112, 2113, NE14 and NE224. We received strains Jacometti, Incrassata and Caudina in 1983; strains 2112 and 2113 were acquired in 1984; strains NE14 and NE224 were recently received in 1986. Consequently, Jacometti, Incrassata and Caudina have been evaluated for a longer period of time and installed in more plantings than the other strains.

To enhance pole survival, we have studied different methods of propagation and establishment techniques (Progress Reports 1984, 1985 and 1986). The parameters were cutting length (8" to 20"), water bath soaking period (10 days to 28 days), planting depth (8" depth to 24" below the water table) and root development (rootless to well developed root system).

Annual plantings of available strains of poplars at the Center have been performed since 1983. In addition, strains Jacometti, Incrassata, Caudina and 2112 were installed off-center in New Mexico at Zuni, Bernardo and Bosque del Apache National Wildlife Refuge. Evaluation of on-center plantings has been conducted annually. Off-center plantings were generally evaluated just the first two or three years after installation.

RESULTS:

We have found through testing, that the hybrid poplars respond similiarly as the native cottonwoods and black willows to our porpagation methods. Consequently, the 10 recommendations presented in conclusion section for establishing native cottonwoods also apply to hybrid poplars.

On-center hybrid poplar plantings have been evaluated since 1983 (Table 7 and Figure 8). The strain Caudina currently has the best survival rate averaging 97 percent and the tallest canopy at 28 feet. However, the canopy width of Caudina after 5 growing seasons is only averaging 6 feet. Canopy width has also been narrow among the other hybrid strains. The strain Jacometti has exhibited the widest canopy, averaging 9 feet. The strain 2112 is promising, after 4 growing seasons it has 100 percent survival and is averaging 20 feet in crown height. The strain 2113 never rooted. After the second growing season, strains NE224 and NE14 are only averaging 2 feet in height.

Off-center performance of the strains Jacometti, Caudina and Incrassata has been variable depending on location. At Bernardo, Jacometti displayed the best survival after the third year at 90 percent. At Zuni, Caudina had the best survival rate after the second year at 80 percent. Incrassata failed to survive at Zuni but survival rate after the second year at Bernardo was 80 percent.

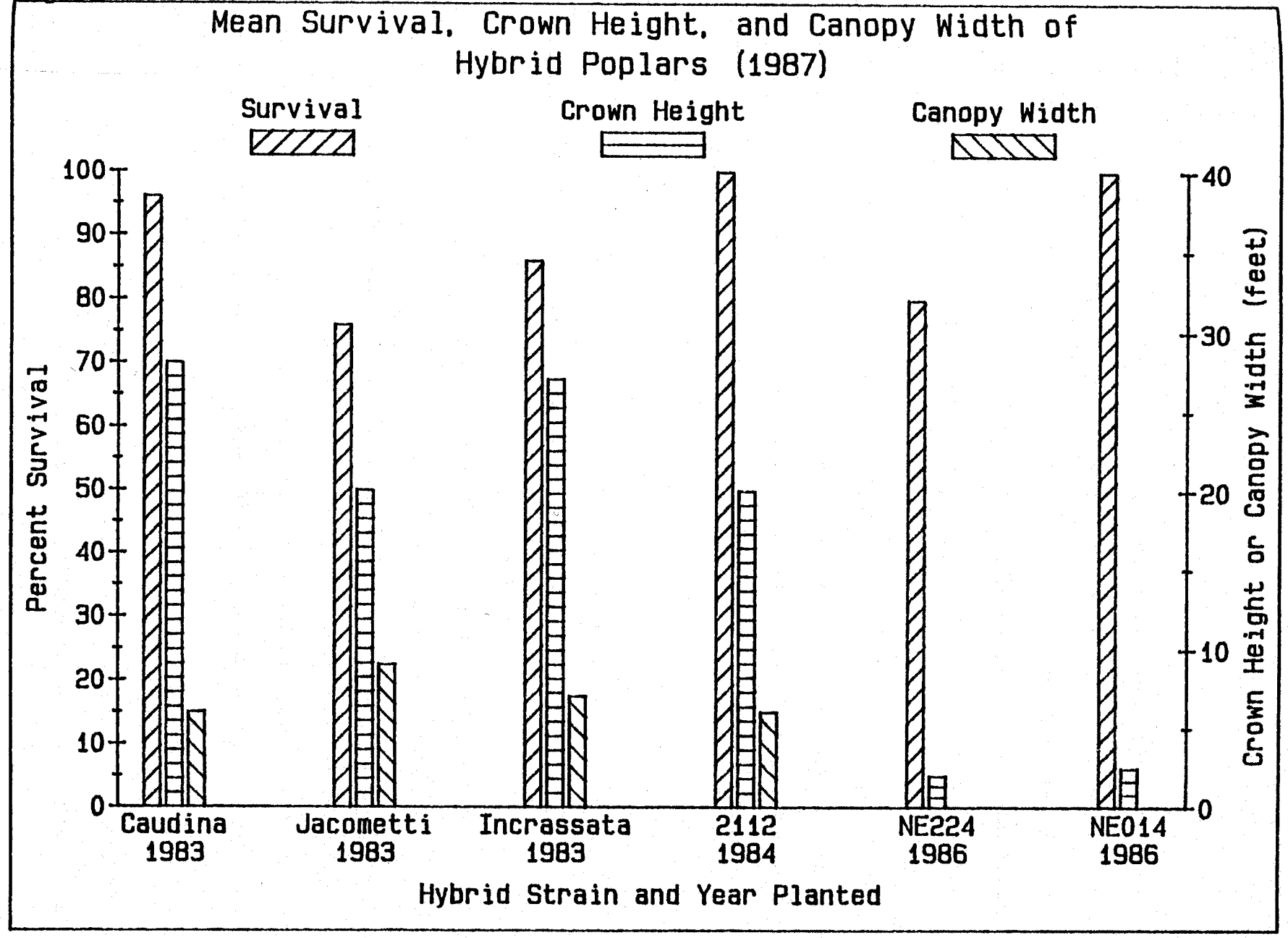
Table 7. Performance data of hybrid poplars for 1984-1987.

Accession	Planting Year	Trans-plants	# Plants Installed	Percent Survival	Crown Height				Canopy Width			Stem Diameter/Caliper				Avg. Foliage Density and Stem Abundance[1]			Average Vigor[1]		
					1984	1985	1986	1987	1985	1986	1987	1984	1985	1986	1987	1985	1986	1987	1985	1986	1987
Caudina	1983	R	12	100	14.0	15.0	16.5	*12.0	03.3	05.0	-	01.5	01.6	02.2	04.4	6/6	5/5	6/4	04.0	04.0	03.0
Caudina	1983	R	12	100	11.0	16.0	17.0	*08.0	05.0	05.0	-	01.5	02.0	02.3	06.1	5/5	4/4	5/4	04.0	03.0	05.0
Caudina	1984	U	27	89	05.0	13.0	25.0	28.0	06.0	06.0	06.0	00.5	02.0	04.0	05.1	4/4	4/4	5/4	04.0	04.0	03.0
Jacometti	1983	R	12	83	08.0	16.0	14.6	*16.0	04.0	06.0	-	01.5	03.0	03.0	06.3	5/5	4/3	6/4	02.0	03.0	03.0
Jacometti	1983	R	12	83	08.0	12.0	16.5	*20.0	05.8	10.0	-	01.5	02.0	04.7	05.9	4/4	4/3	3/4	04.0	04.0	03.0
Jacometti	1984	U	26	61	03.0	16.0	18.0	*20.0	05.5	09.0	9.0	00.5	01.6	03.4	06.0	4/3	4/4	4/4	04.0	04.0	03.0
Incrassata	1983	R	12	92	15.0	13.8	19.0	*11.0	05.1	06.5	-	01.5	02.1	03.5	05.0	5/5	4/3	6/4	04.0	03.0	03.0
Incrassata	1983	R	12	67	14.0	16.0	17.0	*09.0	06.5	05.0	-	01.5	02.5	03.3	05.3	5/5	5/5	5/4	03.0	05.0	03.0
Incrassata	1984	U	9	100	05.0	15.0	27.0	27.0	06.8	07.0	07.0	01.0	02.3	05.4	05.1	5/5	4/3	4/4	03.0	03.0	03.0
2112	1984		4	100	07.0	15.0	18.0	20.0	05.0	06.0	-	01.0	02.0	02.9	08.0	4/4	3/3	3/4	03.0	02.0	03.0
2113	1984	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NE224	1986	-	10	80	-	-	01.5	02.0	-	-	-	-	-	-	-	-	-	-	-	06.0	07.0
NE14	1986	-	10	100	-	-	01.5	02.5	-	-	-	-	-	-	-	-	-	-	-	05.0	07.0

*Pole cuttings harvested in January 1986

[1] = Numerical scale of 1 to 9 with a value of 1 being the most vigorous

Figure 8


Mean Survival, Crown Height, and Canopy Width of Hybrid Poplars (1987)
Survival
Crown Height
Canopy Width
Percent Survival
Crown Height or Canopy Width (feet)
100
90
80
70
60
50
40
30
20
10
0
40
30
20
10
0
Caudina 1983
Jacometti 1983
Incrassata 1983
2112 1984
NE224 1986
NE014 1986
Hybrid Strain and Year Planted

RIO GRANDE COTTONWOOD CUTTING ESTABLISHMENT AS AFFECTED BY LENGTH OF CUTTING, SOAKING PERIOD AND APPLICATION OF THE ROOT STARTER "LIQUINOX"

METHODS:

Propagation methods need to be developed to enhance cottonwood pole establishment in irrigated plantings. Soaking cuttings in a water bath, prior to planting has already shown to enhance survival in earlier studies at the Center. In this study, survival of cottonwood cuttings as affected by length of cuttings, soaking period, and application of the root starter "Liquinox" (vitamin B_1, alpha naphphalene acetic acid and other substances) were evaluated.

During the dormant period of January and February of 1986, 100 pole cuttings of Rio Grande cottonwood saplings were taken near Escondida, New Mexico. These pole cuttings were approximately 15 feet long with a basal diameter of 1 inch to 2 1/2 inches. A total of 120 cuttings of 10 inches, 15 inches, 20 inches and 25 inches were made for each length from the poles and placed in cold storage ($40^{o}F$).

About 30 days later, from March 12 thru March 21, 400 cottonwood cuttings were removed, as needed, from cold storage and the following treatments applied. Cuttings were divided into 4 lots, each containing 25 of the following lengths: 10 inches, 15 inches, 20 inches, and 25 inches. One lot was soaked for 5 days in a $74^{o}F$ water bath in which "Liquinox" had been added. A second lot was soaked in the same water bath for ten days. A third lot was soaked for five days in a $74^{o}F$ water bath containing no "Liquinox". Lastly, a fourth lot was soaked in a water bath containing no "Liquinox" for ten days. Immediately following treatment, the cuttings were planted in a split-split plot design planting without replication (Figure 9). This planting was irrigated as necessary to keep the soil moist only during the initial year of establishment (Table 8).

A fifth lot, containing 20 cuttings of each length (10", 15", 20", and 25") was planted directly from cold storage to the sprinkler irrigated bare root production field (Field 4) on March 25. The cuttings were irrigated regularly by the sprinkler system.

RESULTS:

Since this is a propagation study on establishing cottonwood cuttings, only the intital 1986 establishment year will be discussed in detail. However, the 1987 evaluation revealed similar results for only minimal death loss occurred which appeared randomly within treatments (Table 9).

As shown in previous studies, soaking cottonwood cuttings prior to planting enhanced establishment. However, neither the "Liquinox" treatment nor soaking of the cuttings longer than 5 days tended to enhance survival. Cuttings planted directly into the sprinkler irrigated field without any presoaking treatment had only a 20% survival rate. Cuttings presoaked averaged a 28% survival rate. The non-"Liquinox" and "Liquinox" five day soak treatment survival rates were respectively 41% and 11%. The non-"Liquinox" and "Liquinox" ten day soaked survival rates were respectively 41% and 37%.

Generally, the longer cuttings had higher survival rates. Overall survival rates for the various cutting lengths were 10 inches at 20%, 15 inches at 27%, 20 inches at 37% and 25 inches at 45%.

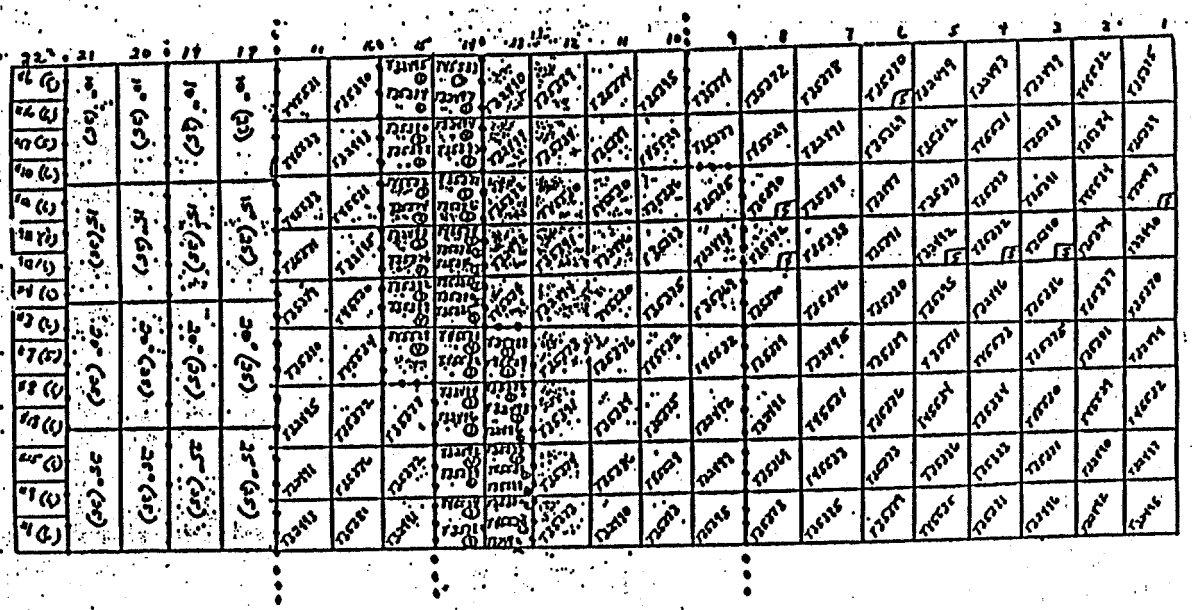
No obvious trends existed considering the interaction effect of the three treatments, length of cuttings, soaking and use of "Liquinox". Cutting survival rates for the 5 day soaked without "Liquinox" were 10 inches at 21%, 15 inches at 36%, 20 inches at 52% and 25 inches at 48%. For the 5 day soaked with "Liquinox" survival rates were 10 inches at 24%, 15 inches at 4%, 20 inches at 4% and 25 inches at 16%. For the 10 day soak without "Liquinox" survival rates were 10 inches at 16%, 15 inches at 40%, 20 inches at 48%, and 25 inches at 60%. Lastly, survival rates for the 10 day soak with "Liquinox" were 10 inches at 16%, 15 inches at 32%, 20 inches at 44%, and 25 inches at 56%.

Unfortunately, this project was not replicated. Survival differences among treatments may be a result of environmental differences occurring within the study plot. Furthermore, without

replication there is no way to derive an estimate of the error variance, necessary to further analyze the results by a statistical analysis.

This study will be redone in 1988. The information that can be derived from this study especially the effect of rooting hormones, preferred cutting length and soaking period, is essential to the success of establishing increase blocks of superior accessions. The project design will be a replicated split-split plot with 3 repetitions In addition, the root hormone Indo-3-Buteric acid will be tested.

FIGURE 9: Plot Plan And Location Of The Four Propagation Treatments In Field 12



5 DAY SOAK	10" (23)	15" (25)	20" (25)	25" (25)	NON-LIQUINOX
	10" (25)	15" (25)	20" (25)	25" (25)	LIQUINOX
10 DAY SOAK	10" (25)	15" (25)	20" (25)	25" (25)	NON-LIQUINOX
	10" (25)	15" (25)	20" (25)	25" (25)	LIQUINOX

TABLE 8

1986 Irrigation Record
Irrigation Application for 1986 Study A - Field 12
Planted March 17, 1986 thru March 21, 1986
4 Inch Gross Application After Transplanting

Date of Irrigation	Gross Application (in inches)	Net Application (in inches)
3/17/86	4	2.5
3/21/86	4	2.5
4/14/86	4	2.5
4/24/86	4	2.5
5/06/86	4	2.5
5/15/86	3	2.0
6/19/86	3	2.0
7/14/86	3	2.0
7/29/86	3	2.0
8/21/86	3	2.0
9/10/86	4	2.5

TABLE 9

Mean Survival For The Four Cutting Lengths
As Affected By The Four Treatments
for 1986-1987.

Treatment Method	10 Inch		15 Inch		20 Inch		25 Inch	
	86	87	86	87	86	87	86	87
5 Day Soak and Non-Liquinox	22	22	36	12	52	40	48	48
5 Day Soak and Liquinox	24	24	0	4	4	4	16	16
10 Day Soak and Non-Liquinox	16	16	40	40	48	48	60	60
10 Day Soak and Liquinox	16	16	32	28	44	44	56	52

NATIVE SPECIES AND HYBRID POPLAR INCREASE BLOCKS

METHODS:

Two increase cutting blocks of superior performing accessions of Rio Grande cottonwoods (SCS 9045532, 9045530, 9032497, 9035381, 9032492, 9032491, and 9035395) and black willows (SCS 9045531 and 9035372) were established in March 1986, in Fields 5 and 6 at the Los Lunas Plant Materials Center. Also included, were superior lines of hybrid poplars, Incrassata, Jacometti, Caudina, and 1112. The two blocks, one using a three foot in row spacing in field 5 and the other using a 5 foot in row spacing in field 6, are being evaluated to determine which in row spacing may yield the greatest quantity and quality of harvestable cutting material.

To establish the two blocks, dormant pole cuttings of the superior performing accessions were harvested in Feburary, 1986. The pole cuttings were cut into 20 inch lengths and placed in cold storage (40^{0} F). Thirty-five cuttings of each accession were removed from cold storage on March 21 and placed in a warm water bath inside the greenhouse for 10 days. The cuttings were planted in Field 5 on March 31. A second batch of 35 cuttings of each accession was removed on April 1 and received the same water soak treatment. The cuttings were planted in Field 6 on April 10.

RESULTS:

Both blocks were evaluated in fall 1987 for survival, crown height, canopy width and trunk diameter (Table 10). Since neither planting had better than a 50 percent survival, evaluation of 5 foot spacing versus 3 foot spacing is inappropriate. Both blocks, as a result of random dying within rows, had plants on 10 foot centers or greater.

Native collections that averaged at least a 70 percent survival were SCS 9035381, 9045531, and 9035372. Accessions SCS 9032497 and 9035395 displayed the tallest canopies averaging over 11 feet. Canopy width was similar among all accessions.

The hybrid strains only averaged a 32% survival rate. However, the strain Incrassata, displaying the best survival rate among hybrids, averaged 74 percent. Additionally, Incrassata was superior in both canopy width (averaging 5.4') and crown height (averaging 14').

The dead cuttings within each block will be removed this winter and replaced with live cuttings to maintain an ample cutting source for future projects. Furthermore, the establishment of at least 8 new increase blocks, each of 1,000 trees, has been initiated.

TABLE 10 - A Listing Of Survival, Crown Height, Canopy Width And Stem Trunk For Native Species And Hybrid Poplar Increase Blocks In Fields 5 And 6 for 1987.

Accession	No. of Plants Installed		Survival (Percent)		Crown Height (Feet)		Canopy Width (Feet)		Trunk Diameter (Inches)	
	Field 5	Field 6	Field 5	Field 6	Field 5	Field 6	Field 5	Field 6	Field 5	Field 6
9045532-C	35	15	26	20	10.2	5.0	7.6	3.0	1.5	0.3
9045530-C	35	30	29	27	10.0	6.6	6.4	4.5	1.8	0.8
9032497-C	35	31	80	53	11.7	8.8	6.4	4.5	1.6	0.8
9035381-C	35	27	91	56	9.5	7.8	5.7	3.9	1.2	0.6
9032492-C	35	30	0	27	--	7.4	--	5.5	--	0.8
9045531-W	35	34	86	91	3.5	8.2	3.9	6.8	0.3	1.1
9032491-C	10	11	20	18	6.0	3.5	4.0	4.0	0.4	0.2
9035372-W	35	35	77	80	5.5	10.6	3.2	6.0	0.5	1.5
9035395-C	45	21	0	81	--	11.4	--	5.0	--	1.4
Incrassata	35	--	74	--	15.0	--	5.4	--	2.4	--
Jacometti	35	--	6	--	15.0	--	5.0	--	3.0	--
Caudina	35	--	9	--	11.3	--	4.3	--	1.3	--
1112	35	--	37	--	12.9	--	3.3	--	2.0	--

OFF-CENTER PLANTINGS OF COTTONWOODS AND WILLOWS

METHODS:

Off-center activities for 1987 included plantings of the 1986 selected top 7 superior cottonwood accessions, 3 top performing black willow accessions and 4 hybrid poplar strains at the following locations: Bernardo, Percha Field, and Bosque del Apache National Wildlife Refuge (Figure 10). A fourth planting of the same collections was made at the Los Lunas Plant Materials Center for a comparison planting.

On January 22, 1987, seventy 15 inch cuttings of first and second year wood were taken from each of the superior cottonwood and black willow accessions. The superior cottonwood accessions were SCS 9032492, 9032495, 9045534, 9045532, 9032497, 9045530 and 9035372. The superior black willow accessions were SCS 9045531 and 9035372. In addition, 40 cuttings were taken from a Tucson, Arizona area black willow accession SCS 9052834.

All cuttings were soaked in a water bath for 10 to 14 days and then planted in sandbeds inside the greenhouse where they remained for 6 weeks. The sandbeds were kept moist until cuttings were lifted for field planting.

On March 10, 1987 thirty cuttings were taken from each of the superior performing hybrid poplars: Caudina, Incrassata, Jacometti, and 2112. Cuttings were soaked in a water bath for 10 days and planted into sandbeds inside the greenhouse. The hybrid poplars spent 2 to 3 weeks in sandbeds.

The cuttings were planted March 11 through April 30, 1987 at the off-center sites. The cuttings at the Los Lunas Plant Materials Center were planted May 15. Ten cuttings of each accession were planted at each location. Prior to planting, each cutting was pruned, leaving only a single two to three inch secondary stem, to reduce evapotranspiration losses. Cuttings were planted in 8 inch ripped furrows at an additional 15 inch depth, leaving only the single two to three inch stem exposed above the soil surface in the furrow. Each cutting was

"watered in" with 2 to 3 gallons. The pre-emergence herbicides "Surflan" and "Casaron" were applied at the Percha Field planting. Surflan was sprayed around the perimeter of the native cottonwoods and black willows. Casaron was applied around the perimeter of the hybrid poplars. No herbicide was applied at the other locations. The method of application of supplemental moisture varied at each planting location. The cuttings at Bernardo were on a drip irrigation system. At Bosque del Apache National Wildlife Refuge, water was pumped into an open ditch irrigation system. The cuttings at Percha Field were planted into the shallow 20 inch water table and consequently received no supplemental water. The cuttings at the Los Lunas Plant Materials Center were flood irrigated as necessary to maintain soil moisture.

A second study was performed comparing the performance of accession SCS 9035395 (our top performing cottonwood accession) to "Run-of-River" poles at Bosque del Apache National Wildlife Refuge, Percha Field and Bernardo. Twelve poles of each accession were soaked 14 days and planted to a 5 foot depth at each location.

A third study was performed in February comparing the effectiveness of a willow tea soak and a plain water soak on stimulating root growth of cottonwood cuttings of accession SCS 9035395.

The willow tea solution consisted of 280 black willow cuttings, approximately 2 inches in length and a diameter of 1/4 inch, soaked in 4 gallons of water for 24 hours. Forty-seven cottonwood cuttings, each 15 inches in length with a diameter of 3/8" to 5/8", were soaked for 24 hours in each treatment.

In addition to the individual projects, 400 poles of "Run-of-River" and 10 poles of our best performing cottonwood (SCS 9035395) were cut in January and delivered to the Bureau of Reclamation. These poles were installed by the Bureau at Perca Field.

RESULTS:

An evaluation on rooting of cottonwoods and blackwillows as they were lifted from the sandbeds revealed the following results: Accessions SCS 9045531, 9035395, 9035372 and 9052834 displayed one hundred percent rooting among individuals (Table 11). In addition, accessions SCS 9052834 and 9035372 had the longest roots, averaging over 2 inches in length. An evaluation of rooting was not done for the hybrid poplars.

By fall of 1987, overall survival among accessions at all locations was poor (Table 12) due to extraneous factors. Consequently, this project will be redone in 1988. All cuttings at Bosque del Apache National Wildlife Refuge and the Los Lunas Plant Materials Center died. At Bosque del Apache National Wildlife Refuge, the irrigation system failed and the cuttings were lost mainly due to drought. At the Los Lunas Plant Materials Center, root systems of cuttings may have been severly damaged during planting operations and late planting may have stressed plants beyond their limit. There was only minimal survival among accessions at the other locations. At Bernardo, there was a possible 2 week lapse in irrigation when a pump failed just after the planting was installed. The only native accession that survived was blackwillow accession SCS 9052834 which displayed an impressive survival rate of 70 percent. However, all the hybrid poplars survived with Caudina showing the best survival rate at 60 percent. At Percha, only 2 native accessions survived, with survival rates for SCS 9035395 at 70 percent and SCS 9052834 at 100 percent. The three hybrid strains Jacometti, Caudina and Incrassata persisted with survival rates of 70, 30 and 60 percent respectively. Ground water salinity was measured at both Percha and Bernardo. At Percha the salinity ranged from 400 to 2100 ppm; at Bernardo salinity ranged from 2700 to 3000 ppm.

Cottonwood accession SCS 9035395 averaged over twice the survival rate of "Run-of-River" cottonwoods in the three plantings at Bosque del Apache National Wildlife Refuge, Percha Field and Bernardo (Table 13).

The test of rooting comparing a water bath treatment to a willow tea showed no significant difference. Cuttings of accession SCS 9035395 displayed at least a 94 percent survival for either treatment.

FIGURE 10: Map Showing the Locations of the Three Off-Center Plantings of Seven Superior Cottonwood Accessions, Three Superior Black Willow Accessions, and Four Hybrid Poplar Strains in New Mexico.

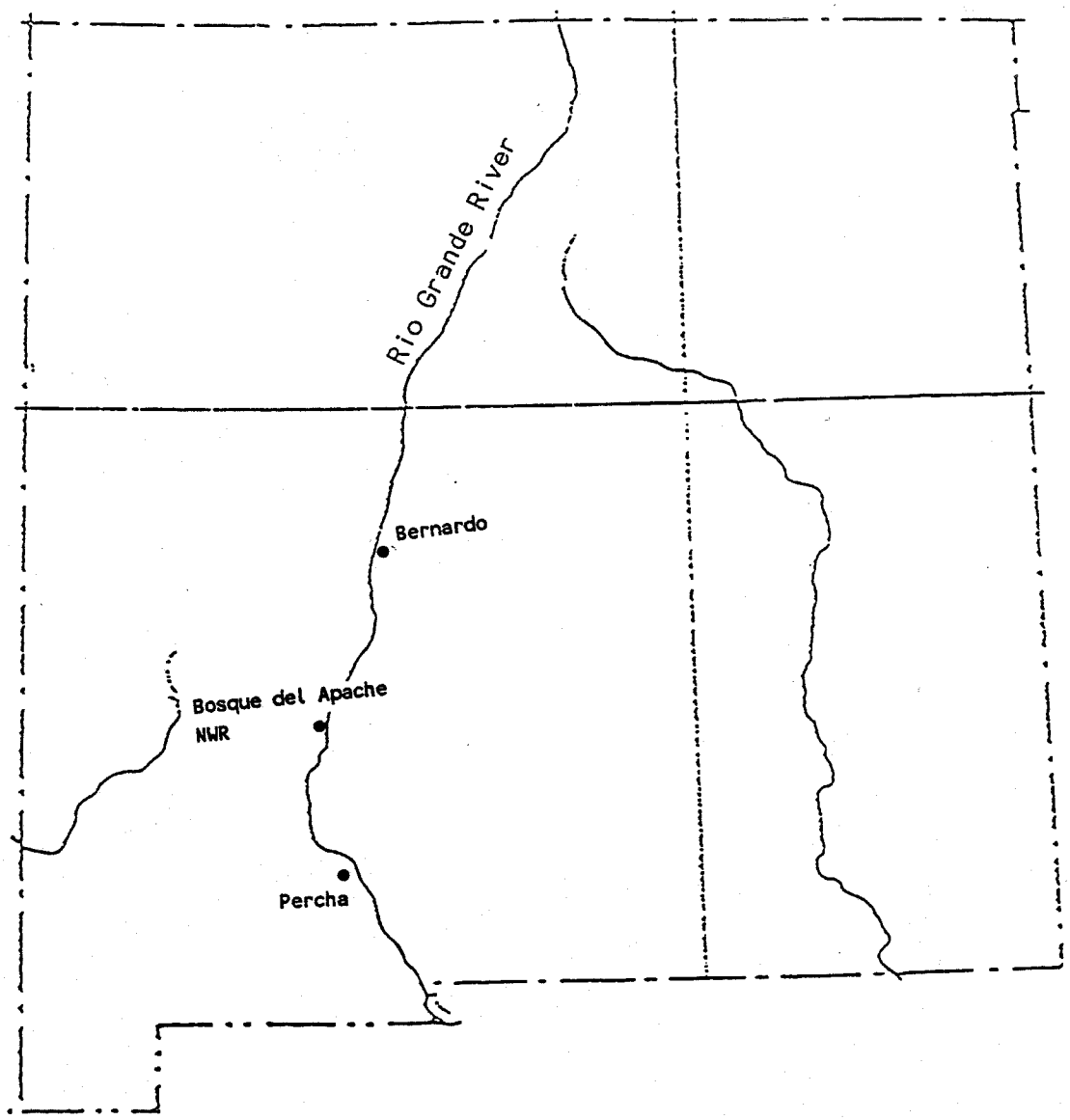


TABLE 11: Evaluation of Rooting of Cuttings Receiving 10 to 14 Day Water Soak and Six Weeks in Sandbeds in Greenhouse.

Accession Number	Percent With Roots	Average Length Of Roots
1. 9032492	65	0.75
2. 9032497	70	0.50
3. 9035372	100	2.00
4. 9035381	90	0.50
5. 9035395	100	1.30
6. 9045530	60	0.50
7. 9045531	100	1.50
8. 9045532	70	0.50
9. 9045534	90	0.50
10. 9045034	100	

TABLE 12: Fall Evaluation of Survival of 15 Inch Rooted Cuttings at Four Locations.

	Accession Number	Percha Field % Survival	Bernardo % Survival	Bosque del Apache % Survival	Los Lunas PMC % Survival
1.	9032492	0	0	0	0
2.	9032497	0	0	0	0
3.	9035372	20	0	0	0
4.	9035381	0	0	0	0
5.	9035395	70	0	0	0
6.	9045530	0	0	0	0
7.	9045531	0	0	0	0
8.	9045532	0	0	0	0
9.	9045534	0	0	0	0
10.	9052834	100	10	0	0
11.	Caudina	30	60	0	0
12.	Incrassata	0	10	0	0
13.	Jacometti	70	30	0	0
14.	T-2112	60	40	0	0

TABLE 13: Evaluation of Survival of Pole Cuttings of 9035395 and "Run-of-River" Cottonwoods.

Location	9035395	"Run-of-River"
Bernardo	0	0
Bosque del Apache	100	40
Percha Field	80	54

CONCLUSION:

Thirty-two collections of Rio Grande cottonwoods and 7 collections of western black willow were taken in 1984 in the Rio Grande Valley from Castilla, New Mexico south to the Fort Craig Ruins near Elephant Butte Reservoir, New Mexico. An initial evaluation planting was established in 1984.

After 4 years of evaluating, 7 superior cottonwood and 3 superior black willow accessions were selected. Currently, the top performing cottonwood accession is SCS 9035395 with an average survival rate of 79 percent, average crown height of 28 feet, and a average canopy width of 13.5 feet after 4 growing seasons. Accession SCS 9035372 is the top performing black willow with an average survival rate of 79 percent, average crown height of 13.6 feet and an average canopy width of 7.3 feet after 4 growing seasons.

Seven strains of hybrid poplars which were considered to be superior by a commercial grower of Sonora, California have been evaluated at the Los Lunas Plant Materials Center since 1983. The hybrids have displayed an excellent overall survival rate of 88 percent and crown height of 27.5 feet after four growing seasons. However, overall canopy width of only 7.3 feet has been disappointing after 4 growing seasons.

The superior collections of cottonwoods, black willows, and hybrid poplars have been tested off-center at the following locations in New Mexico: Zuni, Bernardo, Bosque del Apache National Wildlife Refuge, and Percha Field near Caballo Dam. The best performing accessions were the Cottonwood accessions from Belen, New Mexico (SCS 9035395) and the Black Willow accessions from Pima County, Arizona (SCS 9052834). The hybrid poplar strains Jacometti, Caudina, and Incrassata also performed well.

In establishing cottonwood, black willow and hybrid poplar unrooted pole cuttings without irrigation, the following recommendtions have been formulated after 5 years of testing.

1. Measure water table fluctuations for one year or preferably longer to determine the lowest water table depth.
2. Cut poles from stands of young, rapidly growing trees using only 2 to 4 year old wood.
3. Cut poles while completely dormant, during January and February.
4. Soak poles in water prior to planting for 10 to 14 days.
5. Auger holes to the depth of the lowest anticipated water table. Avoid sites where the water table will be within one foot of ground surface during the growing season.
6. Place the poles in the augered holes within the same day after removal from the soak treatment. Set the butt at the lowest annual water table elevation. Select poles of a length which allows 4-6 feet to be above the soil surface.
7. Back fill the holes carefully to avoid leaving air pockets. The use of dry surface soil is recommended.
8. Place tree guards around the poles if rodent or rabbit damage is anticipated.
9. As buds begin to swell, usually in April or May, if possible wipe them off from the lower two thirds of the pole to reduce evapotranspiration water loss.
10. The planting area must be excluded from livestock grazing for 2 to 3 growing seasons. Furthermore, beaver must be controlled

Plant propagation and establishment studies involving unrotted cuttings under irrigated conditions have continued. The studies have included selected water soaking periods, 10 to 25 inch cutting lengths, and the root starter "Liquinox". In addition, a study comparing the effectiveness of a willow tea soak to a plain water soak on stimulating root growth was conducted. Currently, the only treatment that has tended to enhance non-rooted cutting establishment was a 5 to 10 day water soak prior to planting.

Efforts have been initiated to establish eight new increase blocks, each of 1,000 trees, of our superior black willow and cottonwood accessions. Starting in December 1987, 1,500 6 inch to 8 inch cuttings were taken from each of our superior accessions and started in the greenhouse. The first accession to be prepared was SCS 9035395 and nearly 1,300 cuttings have successfully rooted. The rooted cuttings will be planted late spring after the potential threat of a hard frost is past. By the winter of 1990 we expect to have 8,000 harvestable poles of our superior accessions available for testing.

Plant propagation and establishment studies will continue. Future studies will be replicated and appropriate statistical tests will be conducted. Furthermore, studies will be performed with proven superior accessions to limit the wide range of rooting ability that exist among "Run of River" collections which may confound the results.

Off-center testing of our superior accessions and hybrid strains will continue at an expanded level particularly by 1990 when our new increase blocks have matured. Off-center testing will broaden our knowledge on the tolerance range of superior selections to edaphic factors such as salinity, pH, temperature, moisture, airation and fertility. This off-center testing will help define the range of adaptability of our selected materials.

The search for new superior ecotypes will expand beyond the Rio Grande River drainage into the Pecos River drainage and other saline areas. A broader genetic base will improve our chances on finding those accessions resistant to a specific disease or edaphic factors such as salinity.