SOUTHERN FOREST EXPERIMENT STATION

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COTTONWOOD IMPROVEMENT SYSTEM FOR COMMERCIAL PLANTERS

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SOUTHERN FOREST EXPERIMENT STATION

This publication outlines a simple, inexpensive system of cottonwood *(Populus deltoides* Marsh.) improvement which can be easily and immediately incorporated into an industrial or State planting program. It is recommended for use until improved trees can be bred by more sophisticated but necessarily slower methods.

Cottonwood is currently being planted in the Lower Mississippi Valley on a moderate scale, and expanded industrial investment in plantations is expected during the coming decade. In view of this expansion it becomes increasingly important that planting stock have good genetic potential for growth rate, form, wood qualities, and pest resistance. Because of its capability for vegetative propagation, cottonwood is especially adaptable to genetic improvement through phenotypic selection.

Natural stands of cottonwood in the Mississippi Valley are made up of individuals that vary in growth rate, form, and apparent resistance to pests. The appearance or demonstrable characteristics of each individual make up its phenotype. Phenotypic variation in natural stands of cottonwood usually takes the familiar form of a bell-shaped curve for each characteristic measured.

Much of the variation between individuals within stands and especially between individuals from different stands results from environmental or site effects. Growth rate is especially influenced by site. A large degree of the variation between individuals, however, is due to inherent differences determined by genetic makeup, or genotype. A tree's genotype is fixed throughout its life and interacts with the environment to determine the tree's final form, or phenotype.

In cottonwood a single genotype can be extended, without alteration, through vegetative propagation. The original seedling is termed the ortet and the individual plants arising from its cuttings are known as ramets. A group of ramets originating from a single ortet is a clone. A clone, whether it consists of 10 or 10 million plants, thus represents a single genotype.

The task of the cottonwood improver is to select from a variable population phenotypes

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with superior genetic potential. Using the testing procedures outlined below, he can determine if selected phenotypes are in fact genetically superior. The genetically superior selections can then be propagated by cuttings and planted commercially.

SELECTION

The first step in genetic improvement is to select, either from natural stands or young plantations, phenotypes that appear superior. A natural stand used for selection should be on an extensive, fairly uniform site. A stand close to a large number of seed trees probably will offer a wider range of choice—hence a better chance of finding exceptional trees—than one that originated from a small number of seed trees. For the same reason, plantations should be used for selection only if they were established from seedlings or from cuttings taken from a large number of seedlings. No selections should be made when a superior site or lack of competition is the obvious cause of the good phenotype.

The trees chosen should be 2 to 3 years old; older ones are difficult to propagate vegetatively. At least 50 to 100 plants that are free of disease and insect damage, have no deforming forks or crooks, and are in the upper 1 percent of the stand in terms of height and diameter should be selected. As many 20-inch-long cuttings as possible should be made from each tree.

PROPAGATION

As the cuttings from the selected trees will be too few for a test, they should be propagated in a nursery until there is enough material in each clone (30 to 100 cuttings, depending upon the size of the test). Usually a year in the nursery will suffice; Maisenhelder describes methods for establishing a nursery.[3] Clones must be carefully identified; an easy way is to assign each clone to a single nursery row.

After testing begins, some trees from each clone should be held in the nursery by repeated annual planting or by cutting established trees back to the rootstocks. This will retain clones in the juvenile stage so that they can be easily propagated at any time desired, either for further testing or for commercial planting.

TESTING

The purpose of testing is to compare the performance of selected clones under uniform environmental conditions. This requires that all clones be planted in several replications on a given site.

Special care should be taken to make tests on areas that represent commercial planting sites. Performance of clones will be affected by both genotype and environment, and some clones which do best on a given site can be expected to continue their good performance only on that site or similar ones. Other clones may perform well on all sites tested; they will be of particular interest to the tree improver because of their wider utility. Methods of site quality determination described by Broadfoot[4] are useful in selecting sites.

The test layout described here assumes that 50 clones will be tested on three sites. It can be modified to incorporate additional numbers of clones or replications. The design is a randomized block with four replications on each site (more replications would be desirable). Each replication consists of a different randomization of the 50 clones. A single clone in each replication is represented by two ramets. One possible arrangement of the experiment on a single site is shown in figure 1. It is essential that soil type, depth, and drainage be uniform within each replication.

With planting techniques described by Maisenhelder,[5] the clonal test can be established as a separate enterprise or in conjunction with a commercial planting. In the latter case, selected clones may be planted alternately with standard cuttings. Trees grown from standard cuttings then serve as fillers which can be removed when an initial thinning is needed. Later thinnings can be made by removing one-half the ramets of selected clones. A standard spacing of 12 feet by 12 feet is recommended, and at least two rows of border trees should surround the test. All ramets should be identified as to clonal source (metal tags on heavy wire stakes are suitable) and their

[3] Maisenhelder, L. C. **Cottonwood plantations for southern bottom lands.** U. S. Forest Serv. South. Forest Expt. Sta. Occas. Paper 179, 24 pp., illus. 1960.

[4] Broadfoot, W. M. **Field guide for evaluating cottonwood sites.** U. S. Forest Serv. South. Forest Expt. Sta. Occas. Paper 178, 6 pp., illus. 1960.

[5] Op. cit.

Replication I

31	41	20	28	36	5	42	33	46	*24
31	41	20	28	36	5	42	33	46	24
19	2	27	21	48	18	44	4	23	45
19	2	27	21	48	18	44	4	23	45
47	9	29	38	16	14	50	32	17	30
47	9	29	38	16	14	50	32	17	30
7	40	1	37	49	25	26	43	10	12
7	40	1	37	49	25	26	43	10	12
8	35	13	3	22	6	11	34	39	15
8	35	13	3	22	6	11	34	39	15

Replication II

15	48	3	26	44	20	35	30	9	45
15	48	3	26	44	20	35	30	9	45
21	8	39	10	13	23	1	47	25	4
21	8	39	10	13	23	1	47	25	4
43	14	5	19	22	16	11	12	50	36
43	14	5	19	22	16	11	12	50	36
37	40	2	41	38	28	24	7	42	17
37	40	2	41	38	28	24	7	42	17
6	29	27	31	46	32	34	18	33	49
6	29	27	31	46	32	34	18	33	49

Replication III

16	42	14	9	37	29	15	3	10	49
16	42	14	9	37	29	15	3	10	49
32	50	35	7	41	33	38	44	27	22
32	50	35	7	41	33	38	44	27	22
43	18	28	1	30	8	26	13	25	23
43	18	28	1	30	8	26	13	25	23
21	47	24	31	17	36	4	12	45	40
21	47	24	31	17	36	4	12	45	40
34	19	46	11	6	39	48	2	5	20
34	19	46	11	6	39	48	2	5	20

Replication IV

35	44	1	31	5	9	14	21	24	8
35	44	1	31	5	9	14	21	24	8
22	13	2	41	43	15	23	18	32	42
22	13	2	41	43	15	23	18	32	42
45	48	25	28	38	27	6	20	26	10
45	48	25	28	38	27	6	20	26	10
36	7	16	39	12	29	3	40	19	34
36	7	16	39	12	29	3	40	19	34
47	30	17	11	50	37	4	33	46	49
47	30	17	11	50	37	4	33	46	49

FIGURE 1.—*Experimental layout for a four-replication test of 50 cottonwood clones. Each row-plot* consists of two ramets from a single clone.*

location should be accurately mapped. During the establishment period, the trees should be cultivated as described by Maisenhelder.

Measurements should begin during the first year. Rapid early height growth gives a tree an important advantage over weed competition, and some clones may be selected for this character after the first season. Furthermore, it is desirable to know whether a clone's early performance is indicative of its later development. Relative pest resistance may also be observable during the first season. After the first year, clones can be measured for diameter, height, form, and pest infestation as frequently as costs allow. Wood qualities (specific gravity, fiber length) can be determined from samples cut in thinning. Clonal comparisons should be based on the averages for all ramets in the test.

APPLICATION OF RESULTS

Clones can be selected for commercial use at any stage of testing, but it is best to wait for at least 5 to 10 years. Ideally, clones should be observed for one rotation before heavy investments are made in them. The pressure of needs for improved planting stock will in some cases dictate when selection will begin. When a decision is made to use tested material, at least the best 10 to 20 percent of the clones should be picked. In no case should a commercial planting be restricted to fewer than 10 clones. A selected clone that is superior in desirable characters may also be susceptible to some pest that was not present during testing. Hence, plantations should be mixtures of clones—never large blocks planted with one clone.

Establishment of the test outlined above will, inevitably, be more expensive than planting run-of-the-bar cuttings or random nursery stock. The value of the test will be largely governed by the care taken in establishing it and in making the measurements. The potential for improvement which the system offers should be well worth the effort expended, however. Once superior genotypes are identified the resulting gain is permanent, and the improved stock will be no more expensive to plant than run-of-the-bar cuttings.