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Cutting Orientation and Root Development of Cottonwood

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Cutting Orientation and Root Development of Cottonwood

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THE USE OF UNROOTED CUTTINGS of cottonwood (*Populus deltoides* Bartr.) for plantation establishment is a common practice and it has been recommended that cuttings be oriented in an upright position *(4)*. However, in large scale commercial plantings, much effort is involved in handling and arranging the cuttings to prevent inversion.

Shapiro *(6)* reported that cuttings of *Populus nigra* var. *italica* collected during the dormant season did not exhibit a polar distribution of roots. Instead they initiated roots along their entire length. The authors have observed cuttings, inadvertently inverted during planting, that initiated shoot growth and survived for several weeks. Occasionally inverted cuttings have been found to make near normal height growth. These observations suggest that at least some clones of cottonwood are capable of reversing their polarity and that the effort made to plant cuttings in an upright position is unnecessary. The present investigation was conducted to determine the extent to which orientation influences root development on cottonwood cuttings and the effect of auxin treatment on this process.

METHODS

One-year-old cottonwood sprouts growing in the Auburn Forest Nursery provided the source of the cuttings used. Original collections of cuttings were made along the Alabama River in Clarke County, Alabama. Fifteen cuttings, 0.25-0.5 inches in diameter and 6 inches long, were collected from each of 10 clones. Cuttings were collected from the nursery in January.

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Five treatments with 10 replications in a completely randomized design were used. For each treatment, three cuttings were selected from each clone, randomly mixed, and treated. Following treatment, cuttings were planted in 6-inch plastic pots containing a (1:1)sand-vermiculite mixture. Three cuttings were planted per pot and were then placed under intermittent mist spray in the greenhouse. Natural daylight was supplemented with 300 W incandescent lights to give a photoperiod of 16 hours. The treatments were as follows:

Ck (check) – basal end of cutting soaked 4 hours in distilled water and planted upright.

In (inverted) – apical end of cutting soaked 24 hours in distilled water and planted apical end down.

SI (soaked and inverted) – basal end of cutting soaked 24 hours in 25 p.p.m. indole-3-acetic acid (IAA) and planted apical end down.

SU (soaked and upright) – basal end of cutting soaked for 24 hours in 25 p.p.m. IAA and planted basal end down.

IS (inverted and soaked) – apical end of cutting soaked 24 hours in 25 p.p.m. IAA and planted apical end down.

Cuttings were potted in late January. After 41 days the plants from five replications of each treatment were removed from the pots and washed free of rooting medium so that measurements could be made. The remaining potted plants were removed from the mist bed and maintained in the greenhouse for an additional 6 months.

RESULTS AND DISCUSSION

All cuttings had survived and initiated shoot growth after 41 days, hence, inversion did not affect early survival. However, the number of roots produced per cutting was much lower on inverted cuttings than on those planted upright, Table 1, Figure 1. Shoot growth was also reduced by inversion, Table 1. This agrees with the findings of Allen and McComb *(1)* for cuttings collected in late winter.

The shortage and sometimes complete absence of root development on inverted cuttings indicated that survival would have been much lower had these studies been conducted in the field rather than under mist-bed conditions. When the remaining potted cuttings were transferred from the mist bed to the greenhouse bench, mortality began to occur among the inverted cut-

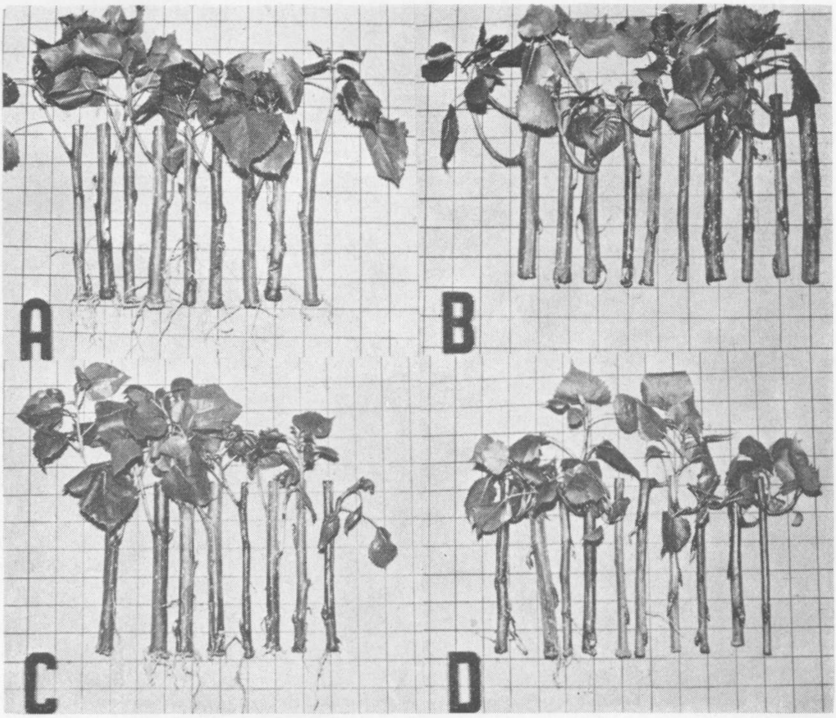

FIG. 1. Representative cuttings 41 days after planting; A—check; B—inverted; C—soaked and upright; D—inverted and soaked.

TABLE 1. AVERAGE NUMBER AND LENGTH OF ROOTS AND SHOOTS 41 DAYS AFTER PLANTING

Treatment	Roots[1]	Length of roots	Shoots	Length of shoots
	No.	*mm*	*No.*	*mm*
Check	6.20	33.6	1.65	73.5
Inverted	0.70*	15.4	1.80	53.4*
Soaked and inverted	0.35*	9.5*	2.00	53.1*
Soaked and upright	5.35	37.2	1.65	61.1
Inverted and soaked	0.70*	29.6	2.05	42.0*

[1] An asterisk indicates a significant difference from the Check at the 5% level.

tings. After 6 months, only 4 of the 90 cuttings that were planted upside down survived. The upright cuttings grew several feet in height and were discarded after 4 months since they were difficult to maintain in 6-inch pots.

Of the 4 inverted cuttings surviving after 6 months, 3 were typified by weak, distorted top growth and a pronounced swelling of the end of the cutting projecting above the medium (originally the basal end), Figures 2 and 3. However, these cuttings possessed abnormal but extensive root systems, Figure 2b.

One inverted cutting exhibited near normal shoot growth. When the roots were washed free of medium, the reasons for normal shoot growth were apparent. The dominant shoot emerged from below the ground line and roots formed **on the new shoot** after it began to elongate, Figure 4. Thus, normal polarity was resumed. This reaction is occasionally noted with certain other woody plants *(2)* and probably accounts for the occasional survival of inverted cottonwood cuttings under field conditions.

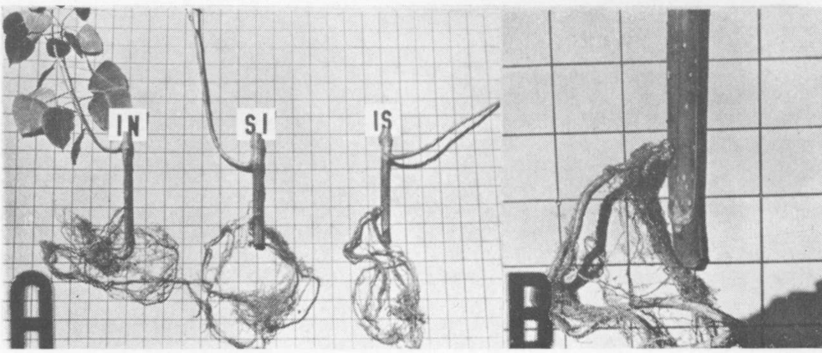

FIG. 2. A. Representatives of inverted cuttings 7 months after planting: IN—inverted; SI—basal end soaked in IAA and planted inverted; IS—apical end soaked in IAA and planted inverted. B. Closeup of inverted cutting showing abnormal swellings near base of root.

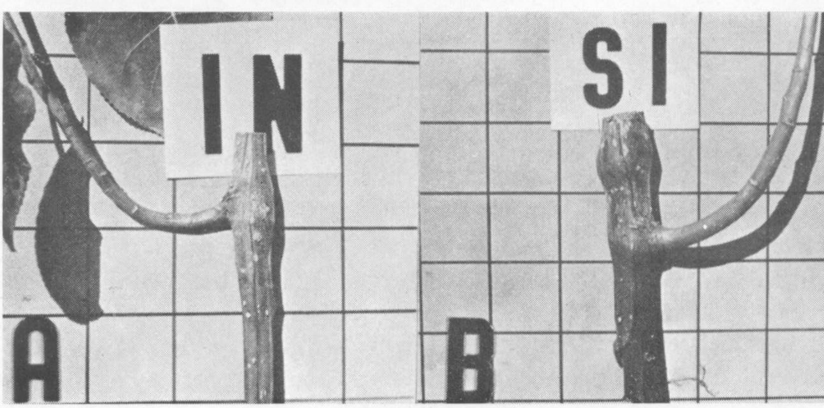

FIG. 3. Closeup of two of the cuttings in FIG. 2 showing the swelling near the upper end of the cutting: IN—inverted; SI—soaked and inverted.

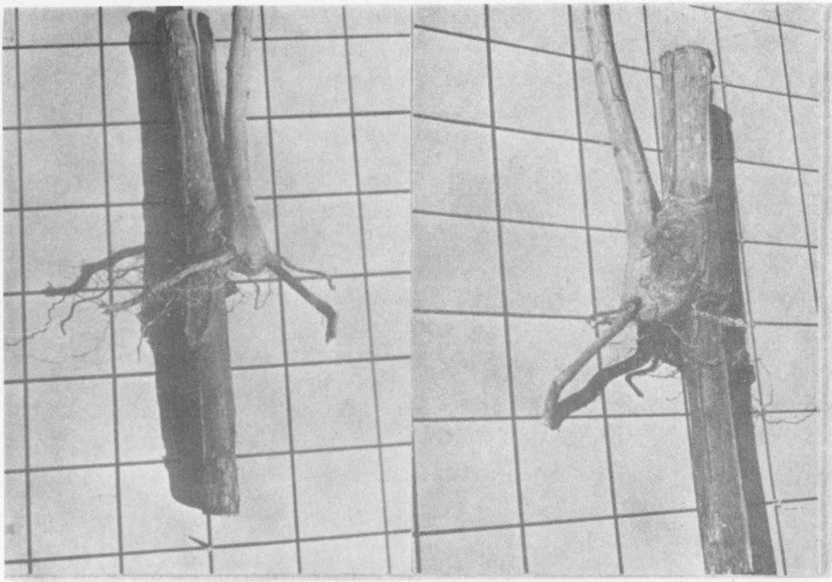

FIG. 4. Two views of inverted cutting that made normal shoot growth. Note how roots emerged from base of new shoot thus establishing normal polarity.

It appears that cottonwood cuttings root and grow much better when planted upright than when inverted. The additional expense of orienting cuttings properly before planting seems justified. Occasionally, shoots originating below ground level may form adventitious roots and make normal development; however, only 1 cutting out of 90 did so in this study.

The fact that a few cuttings formed extensive root systems even when planted upside down suggests several interesting considerations. Water uptake and transport must have occurred or the shoots would not have survived for several months after removal from mist. Although heavily fertilized, the inverted cuttings did not develop the large, succulent leaves characteristic of cottonwood under conditions of high fertility. This suggests that salt uptake and transport may have been restricted in the inverted stems.

Movement of photosynthate in the phloem does not appear to be polar *(7)*. Hence roots on the inverted cuttings could obtain their energy source from the leaves. Auxin movement, while highly polar in short sections of many plants, is not thoroughly understood in whole plants *(5)*. Little and Blackman *(3)* found that IAA could be exported from bean leaves by normal phloem transport. Most of the inverted cuttings that survived for several months during the present investigation exhibited a pronounced swelling at the upper extremity, Figure 3. Such swellings are frequently observed above phloem girdles. Since these cuttings possessed a developing root system to serve as a "sink," phloem transport would be expected to occur toward the roots. However, if auxin movement remained polar, auxin would accumulate at the upper end of the inverted cutting and this would explain the proliferation of cells observed in these studies. Such proliferation may create a new "sink" and divert photosynthate and nutrients from both root and shoot growth.

Since inverted cottonwood cuttings develop roots and shoots survive for an extended period, they have potential value in the study of auxin movement in whole plants. This is a subject upon which much additional information is needed *(5)*.

SUMMARY

Cuttings of eastern cottonwood (*Populus deltoides* Bartr.) were planted both upright and inverted and with and without various auxin treatments. Treatment with auxin (indole-3-acetic acid) had little effect upon root development and growth, however, inversion had pronounced effects. The number and length of roots and the length of shoots on inverted cuttings was far below the controls. However, several inverted cuttings initiated extensive root and shoot growth and survived for more than 9 months. Roots on inverted cuttings were swollen and distorted near the base. Leaves on inverted cuttings were small and slightly chlorotic, typical of plants growing under conditions of low fertility. The rooting medium was heavy fertilized and cuttings planted upright developed large succulent foliage. Apparently, mineral uptake and movement was abnormal in the inverted cuttings. Pronounced swellings developed at the upper end of inverted cuttings, suggesting that auxin movement from shoots was continuing to be polar according to the original polarity of the cuttings. One inverted cutting initiated shoot growth below the ground line. The new shoot formed adventitious roots, thus establishing a new polar axis and shoot growth was normal.

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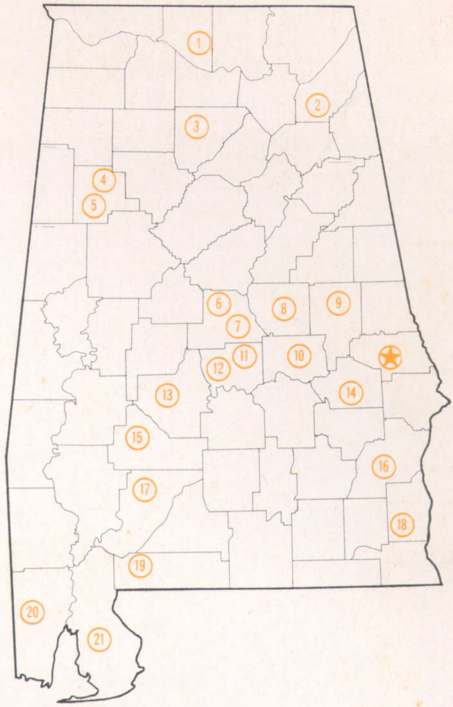

Research Unit Identification

★ Main Agricultural Experiment Station, Auburn

1. Tennessee Valley Substation, Belle Mina.
2. Sand Mountain Substation, Crossville.
3. North Alabama Horticulture Substation, Cullman.
4. Upper Coastal Plain Substation, Winfield.
5. Forestry Unit, Fayette County.
6. Thorsby Foundation Seed Stocks Farm, Thorsby.
7. Chilton Area Horticulture Substation, Clanton.
8. Forestry Unit, Coosa County.
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