# PROPAGATION TECHNIQUES FOR ROOTING CUTTINGS OF PECAN, *CARYA ILLINOENSIS*

by

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# I. INTRODUCTION

The pecan, Carya Illinoensis, K. Koch is a hickory and, along with walnuts, belongs in the Juglandacea family. Since the pecan can produce one of the few native North American pomological crops, and of all the horticulture products given by our continent to civilization, none is of more importance, nor destined to play a more vital role in our pomological future (McHatton, 1957). Indigenous over a large area of North America, it has taken four hundred years for this plant to become a cultivated crop. Thus, research is still in an initial state. Much information is needed about the pecan, especially in the area of propagation, before this horticultural crop can play a more vital role in the future, not only in North America where it is native, but in the whole world (10).

Commercial propagation of pecan is by either budding or grafting superior cultivars onto seedling rootstock. Problems with using seedling rootstocks include: 1. genetic variability, creating variability in cultivar performance, because, as in many pomological crops, rootstock has a great effect on the scion cultivar; 2. it is expensive and time consuming to graft and bud pecans since only moderate levels of success are achieved; 3. the difficulty of transplanting the pecan with its central root system; and 4. without clonal rootstock, research is limited; accurate data cannot be obtained.

The objectives of this research were: 1. to obtain a suitable fungicide for use in propagating pecan cuttings; and 2. to investigate effects of apical bud and cultivar on the rooting of pecan cuttings from an adventitious source (10, 13, 19).

## II. REVIEW OF LITERATURE

### A. Techniques of Propagating Pecan Cuttings

The first reported research in the area of pecan propagation from cuttings started with Stoutemyer (15) in 1938, who rooted dormant hardwood Greenriver pecan cuttings by pre-callusing and treatment with indolebutyric acid (IBA). Stoutemyer failed to state if the cuttings continued to grow.

Gossard (5) 1942, reported ability to get roots from pecan stems with considerable success by trench layering tops of grafted or budded nursery trees and by air layering of older trees in marcot boxes in conjunction with IBA treatments by toothpick method developed by Romberg and Smith (12). Gossard (6) again reported in 1944 the rooting of pecan cuttings under continuous mist but none survived transplanting.

Odom (11) in 1965 stated that the non-rooting of pecan did not appear to be entirely related to lack of or low levels of auxin. It was also found that the levels of auxin in pecan were higher in November and April than in February.

Sparks and Pokorny (14) in 1967 studied the effects of wound treatment and root-inducing chemicals on rooting of terminal pecan cuttings taken at four dates. Their investigation showed that: 1. rooting was inversely related to the maturity of the terminal; 2. IBA plus a light wound gave the highest rooting percentages; and 3. root quality was poor.

Wolstenholme (19) 1969, found 1,000 ppm IBA in talc produced 23.2 rooting percentage per treatment. A fifteen minute soaking in a solution containing 1,000 ppm IBA and 0.5 Dimethyl Sulfoxide (DMSO) produced cuttings with 20.7 roots per plot. No report was made of successful transplanting.

Taylor and Odom (16) 1970, reported the presence of a compound similar to juglone in the stem cuttings of pecan that was inhibitory. It appeared to be a significant factor in the rooting complex of pecan stem cuttings.

Recently, Brutsch (2) of South Africa has shown that an 18-hour photo-period provided during and after the rooting period under intermittent mist allowed significant numbers of the rooted cuttings to grow and become established.

McEachern and Story (9) reported in August of 1972 that dormant juvenile stem cuttings were successfully propagated if taken in January during mid-rest. When bottom heat was supplied, seventy-two percent rooting in 4 weeks was reported.

Shreve (13) also reported in fall of 1972 that pecan cuttings from adventitious shoots formed roots in 15 days and shoot growth in 35 days. While pecan cuttings from visible bud sources formed roots in 30 to 70 days, none developed shoots. Rooted walnut and pecan cuttings were transplanted successfully if the roots had laterals formed and leaves were retained at time of transplanting. Shreve also states that results of studies he made indicate that it is practical to produce genetic duplicates of walnuts, chestnuts and probably pecans from desirable trees. He further states that genetic duplicates can be produced of any woody plant that will develop adventitious shoots.

B. Factor of Juvenility

Hartmann and Kester (7) described juvenility as follows:

> The physiology of a young seedling plant differs from that of mature plants. This is shown in some cases by the fact that cuttings taken from young plants have a greater tendency than those taken from older plants to initiate adventitious roots. In some plants the difference in the internal state is also manifested by striking differences in morphological characteristics, such as difference in leaf shape or greater thorniness in younger plants. This immature condition is referred to as juvenility. It is an important aspect of propagation. (p. 56)

Brink (1) reported in 1962 that seedlings revert to the juvenile state and undergo the same stages of changes to the adult form as did the parent plant and the plant apical meristem changes as it matures while genetic information remains unchanged.

Most of the reported successes in rooting pecan cuttings have been with this juvenility factor (9, 13, 19). McEachern and Story (9) state that juvenile shoots have a pronounced pubescence and a slight red color, and can only be taken from the lower 10 feet of a mature tree.

C. Fungicidal Effects on Rooting of Cuttings

The propagation of cuttings under mist during the rooting period make conditions ideal for attacks by various fungi especially when bottom heat is supplied (7).

White (17) 1946, working with geranium cuttings, was not sure whether improved rooting was from controlling the fungus, a direct fungicidal promotion of root initiation, or both.

Several authors reported (7, 17) (or have shown) that Captan (N-trichloromethyl mercapto-4-cyclohexene-1,2-dicarboximide) greatly improved rooting of some cuttings. White (17) states that since Captan promotes complex changes in sugar metabolism in plants that this could account for the promotion of root growth. Since Captan is a long residual fungicide, it is an ideal fungicide for use on cuttings (7).

The only reported source of using a fungicide in the propagation of pecans was Shreve (13), who used a 4-4-8 Bordeaux mixture in the propagation of walnuts, chestnuts and pecans.

## III. MATERIALS AND METHODS

### A. Fungicide Experiment No. I

#### 1. Procedure

Dormant hardwood deciduous seedling pecan cuttings of previous season's growth were taken on February 29, 1972. The cuttings were obtained from nine-year-old seedling pecan trees grown at the Kansas State University Horticulture Farm, Manhattan, Kansas. Wood of moderate size — about 1.7 cm in diameter and 23 cm long — were of the straight type (vs. heel). Cuttings were washed and surface-sterilized with a 10% Clorox solution and then soaked ten minutes in Panogen 16 fungicide (2.2% mercury, at the rate of 2 tsp. to 10 gal. of tap water). The distal end of each cutting was painted with "Treekote" tree wound dressing, pruning and grafting compound (a product of Walter E. Clark & Son, Orange, Conn.). Cuttings were then placed in bundles of 50, packed in sterilized moist peat moss in plastic bags within waxed boxes, and stored at 3° C.

When cuttings were removed from storage, and after the basal 1.5 cm of the cutting were removed, they were treated with IBA and fungicide. The treated cuttings were placed in an insulated propagating box in cold storage unit maintained at 3° C. The basal ten centimeters of the cuttings were set in a moist media of 1:1:1 peat/perlite/vermiculite maintained at 25° C by heating cables. The remaining distal part of the cuttings (12.5 cm) was exposed to the ambient temperature (3° C) to maintain dormancy.

2. Treatments

There were ten treatments, involving four fungicides, listed in Table 1 of Results. Application of 4,000 ppm IBA in absolute ethanol was made to the cutting in a thirty second dip to a depth of 9.5 cm, followed by a complete soaking of the entire cutting for 1 minute in the fungicide.

3. Data collected

Data taken on July 12, 1972, one month after the experiment was started, were centimeters dieback from the base toward the distal end of the cutting, with bud break, fungi growth, and rooting also noted.

B. Origin of Cutting Experiment No. II

1. Procedure

Pecan softwood cuttings 23 cm long of current seasons growth were taken August 1, 1972, from seedling pecan trees grown at Kansas State University Horticulture Farm. Cuttings were taken from both adventitious and visible bud origin sources. The cuttings were treated with IBA and set to a depth of 10 cm. Propagation was carried out in a greenhouse using a media of horticultural grade perlite. Air temperature at the cutting level was maintained between 20-30$^{o}$ C. The propagation medium was maintained at 25$^{o}$ C by heating cables. The softwood cutting received a 3 second intermittent mist every 2 minutes for 24 hours a day. All cuttings remained in the bench 60 days.

2. Treatments

Cuttings were derived from either adventitious or visible bud shoots and apical buds were either present or removed as shown in Table 2 of Results. IBA was applied to all cuttings at 8,000 ppm in absolute ethanol, 2 second dip to a depth of 5 cm. Cuttings were sprayed every 10 days with Benomyl fungicide at the rate of 1 TBS/gal. $H_2O$.

3. Data collected

Data was taken on September 30, 1972 with success measured by number of rooted cuttings alive after 60 days. Successfully rooted cuttings had 3 roots that were branched several times with secondary roots, as shown in Plate 1.

C. Pecan Cultivar Rooting Experiment No. III

1. Procedure

Several hardy northern pecan cultivar cuttings were taken from trees grown at Kansas State University Horticulture Farm. Age of tree is stated in Table 3. A lower limb was removed which is larger than 15 cm in diameter, leaving no visible buds present. The bases of the limbs were allowed to form adventitious shoot growth. Cuttings were taken from those shoots that developed visible lenticals and were at least 20 cm in length and .75 cm in diameter. Cuttings were treated with IBA (8,000 ppm in absolute alcohol, 2 second dip) and set to a depth of 10 cm in the propagation media. Propagation was carried out in a greenhouse as in Experiment No. II.

2. Treatments

Seven pecan cultivars were used as shown in Table 3. Indolebutyric acid was applied as in Experiment No. II.

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PLATE 1

| | |
|---|---|
| Top Center | Rooted softwood pecan cutting with terminal bud removed. |
| Middle Center | Rooted softwood pecan cutting showing roots that are branched several times in order to be successfully rooted cutting. |
| Bottom Center | Softwood cuttings with terminal buds left on. Cutting to right shows no rooting response. |

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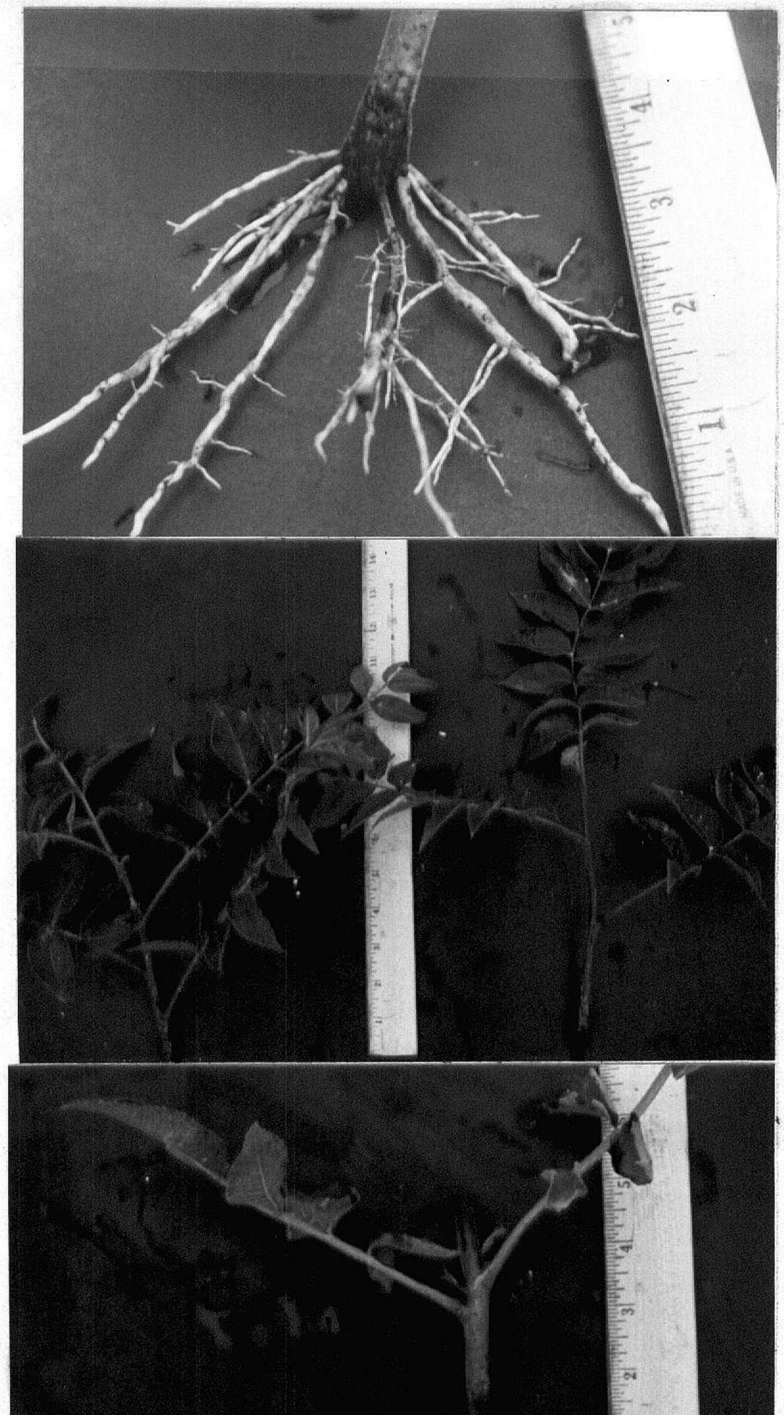
PLATE 1



3. Data collected

Data was taken on October 30, 1972 with success measured by the number of rooted cuttings alive after 90 days. All cuttings remained in the mist bed for 90 days.

D. Statistical Analysis

A completely randomized design with four replications was used as the experimental design for all experiments. All treatments consisted of 10 cuttings. All data were analyzed by a one way analysis of variance. The Fisher's least significant difference (LSD) test was used to determine the significance among means at 5% level (4).

## IV. RESULTS

### A. Fungicide Experiment

The effects of 4 fungicides and IBA at 8,000 ppm on dormant hardwood decidious seedling pecan cuttings under experimental conditions are summarized in Table 1 as centimeters of dieback from the base of the pecan cuttings. Also, percentage of cuttings, rooting, budbreak and estimated control of fungal growth are presented.

In all cases the use of fungicide or IBA or combinations of both significantly reduced dieback. Cuttings treated with Benomyl either with or without IBA had significantly less dieback than all other treatments except Captan. It was the only fungicide treatment that reduced dieback more than did IBA without fungicide.

Using the treatment IBA and no fungicide reduced dieback below the check, but in no cases did IBA improve the effect of fungicide.

All treatments having IBA visibly reduced bud break of the buds that were in the warm media of 25° C. Those not having IBA in the treatment had bud breaking at the 85 percent level. The benomyl plus IBA treatment had the least bud break.

The best rooting performance occurred with benomyl plus IBA, but this was only 10 percent of the cuttings. Captan plus IBA had an average of 5 percent, and 0-fungicide and IBA alone had an average of 6 percent. Cutting from all other treatments had

Table 1. Effect of fungicides and IBA on hardwood seedling pecan cuttings in propagation bed with bottom heat. Data are the amount of dieback of cuttings, the percentage of bud break in media, percentage of cuttings rooting and presence of visible surface fungal growth.[1]

| Fungicide and Rate | IBA 30 sec dip | Dieback of cutting | Bud break | Rooting of cutting | Estimated control of fungal growth |
|---|---|---|---|---|---|
| | | cm | % | % | % |
| Benomyl 1 TBS/gal $H_2O$ | 4,000 ppm | 3.25 a[2] | 5 | 10 | 100 |
| Benomyl 1 TBS/gal $H_2O$ | none | 4.00 a | 85 | 0 | 100 |
| Captan 5 1/3 TBS/gal $H_2O$ | 4,000 ppm | 4.50 ab | 5 | 5 | 75 |
| Captan 5 1/3 TBS/gal $H_2O$ | none | 5.00 ab | 85 | 0 | 75 |
| Bordeaux 6 TBS/gal $H_2O$ | 4,000 ppm | 7.00 bc | 5 | 0 | 0 |
| None | 4,000 ppm | 7.00 bc | 5 | 6 | 0 |
| Bordeaux 6 TBS/gal $H_2O$ | none | 8.00 c | 85 | 0 | 0 |
| Juglone 100 mg/100 ml $H_2O$ | none | 8.00 c | 85 | 0 | 0 |
| Juglone 100 mg/100 ml $H_2O$ | 4,000 ppm | 9.00 c | 5 | 0 | 0 |
| None | none | 15.00 d | 85 | 0 | 0 |
| LSD .05 = | | 2.67 | | | |

[1]Average from 10 cuttings in each of 4 replicates.

[2]Number with same letters are not significant at the 5% level.

no rooting.

Benomyl effectively controlled all fungal growth, (Trichoderma birides and Alternaria Sp.), in both benomyl treatments. Captan controlled mold growth on 75 percent of cuttings from both Captan treatments. The remaining treatments, including IBA, had no visible effect on fungal growth over the check.

B. Origin of Cutting Experiment

Table 2 shows the rooting performance of cuttings taken from adventitious or visible bud shoots as affected by presence of the terminal bud. The amount of rooting of softwood cuttings was significantly greater in the adventitious cutting with the terminal bud removed where 90 percent rooting occurred. The second best rooting occurred with adventitious cutting with the terminal bud, but only 50 percent of the cuttings rooted. Poorest performance of rooting occurred with visible bud cutting with apical bud present; only 10 percent rooted. Removing the apical bud from the terminal cutting increased rooting by 15 percent in visible bud cuttings and 40 percent in the adventitious cuttings.

C. Pecan Cultivar Experiment

The rooting performance of cuttings from selected hardy Northern Pecan cultivars using IBA at 8,000 ppm (2 second dip) and benomyl fungicide under intermittent mist is summarized in Table 3. Significant differences occurred among cultivars. Coy and Greenriver had the highest percentage of rooting, 37.5 per-

Table 2. Effect of origin of terminal softwood seedling pecan cuttings taken Aug. 1, and presence of apical bud on rooting using 2 second dip of IBA 8,000 ppm and benomyl fungicide.

| Origin of cutting | Apical bud | Percentage of cuttings rooted[1] |
|---|---|---|
| Adventitious | Removed | 90% a[2] |
| | Present | 50% b |
| Visible Bud | Removed | 25% bc |
| | Present | 10% c |
| LSD .05 = | | 26 |

[1]Average of 10 cuttings each of 4 replications.

[2]Numbers with same letters are not significant at the 5% level.

Table 3. Rooting performance of pecan cultivars of softwood adventitious terminal stem cuttings with apical bud removed. Cuttings treated with two second dip of IBA 8,000 ppm and benomyl fungicide.

| Pecan cultivars | Approximate Age of Trees | Percent of cutting rooted[1] |
|---|---|---|
| Coy | 30 yrs. | 37.5% a[2] |
| Greenriver | 30 yrs. | 30.0% ab |
| Hirschi | 12 yrs. | 17.5% bc |
| Major | 30 yrs. | 17.5% bc |
| Indiana | 30 yrs. | 10.0% cd |
| Posey | 30 yrs. | 05.0% cd |
| Stark's Hardy | 12 yrs. | 00.0% d |
| LSD .05 = | | 15.7 |

[1]Average from 10 cuttings each of 4 replications.

[2]Numbers with same letters are not significant at 5% level.

cent and 30 percent, respectively. Stark's Hardy had no rooting, while Posey with 5 percent of the cuttings rooting and Indiana with 10 percent were second and third lowest.

## V. DISCUSSION

Evidence gained showed that fungicides, origin of cutting and cultivar selection affects the rooting of pecan cuttings.

It was found in Table 1 that fungicides were beneficial. All treatments with fungicides and IBA or both reduced dieback below the check and were significant at the 5% level. The fact that IBA alone controlled dieback seems to support the hypothesis that IBA, a synthetic growth regulator promoting root growth, keeps the cutting healthy by not allowing the bud to break in the warm media ($25^{o}$ C). By controlling bud break, excessive respiration related to succulent shoot growth was prevented. Also entry of fungi through tender new leaf growing in a moist environment was prevented.

Benomyl controlled dieback more than any other fungicides except Captan and was the only fungicide that controlled more dieback than IBA alone. Benomyl is a systemic fungicide and thus was taken into the cuttings while the others remained on the outer surfaces of the cuttings. Benomyl seemed to have more residual life possibly because it is taken up by the cuttings.

The benefit obtained from using fungicides in the experiment agrees with the results of White (17) and Hartmann and Kester (7). Fungicides should give protection against fungi, and some bacteria depending on the fungicide used, and thus will result in disease free cuttings that have improved root quality, and better transplant vigor.

Adventitious cuttings rooted better than visible bud cuttings almost 4 to 1 (Table 2). This agrees with the research of Brutsch and McEachern (9) and Shreve (15). Rooting was further promoted by removal of the apical bud. This indicated some physiological inhibition for root initiation from the apical bud. Fadl and Hartmann (3) 1967, found that the apical buds of Bartlett pear produced some inhibition which interfered with metabolic reactions promoting adventitious root production.

In the pecan cultivar experiment, differential rooting of cuttings was observed. Certain cultivars rooted more readily than others. Coy and Greenriver had the highest percentage of rooting. On this basis, these two cultivars could be considered for rootstock propagation in order to have a clonal rootstock for pecan. Major and Indiana had moderate rooting (10-17 percent). The fact that age of the trees was different is a criticism, but Starking, the youngest tree, failed to root. Coy and Greenriver being of the oldest cultivar trees, had the highest percentage of rooting.

## VI. SUMMARY AND CONCLUSIONS

Results of this study lead to the following conclusions:

1. Centimeters of dieback per cutting from base was decreased when a fungicide or IBA or both were used. The systemic fungicide benomyl was more effective.

2. Bud break on the portion of the cutting within the warm media was greatly reduced with IBA.

3. Rooting percentages were higher with the use of cutting from adventitious shoot origin than those from visible bud origin.

4. Rooting was further enhanced when apical bud was removed on adventitious bud origin of cuttings.

5. Certain Northern pecan cultivars root easier than others. Coy and Greenriver rooted significantly better than other pecan cultivars used in experiment.

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## LITERATURE CITED

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Research was conducted at Kansas State University, Manhattan, Kansas, February-November of 1972 on the asexual propagation of pecans from cuttings.

Cuttings used for fungicide experiments were dormant hardwood treated with auxin (IBA 4,000 ppm, 30 sec. dip) or fungicide or various combinations of auxin and fungicide. Treated cuttings were placed in an insulated propagating box and maintained in cold storage unit at $3^{\circ}$ C, to keep top of cuttings dormant. The basal 10 cm of the cuttings were in a mixture of peat/perlite/vermiculite maintained at $25^{\circ}$ C. Data were recorded as centimeters of dieback after 30 days. In all cases use of fungicide or IBA or combinations of the two significantly reduced dieback. Cuttings treated with benomyl had significantly less dieback than those treated with IBA. Captan, Bordeaux and juglone treatment alone was no better than IBA in controlling dieback. Ten percent of cuttings treated with benomyl and IBA rooted.

The rooting performance of cuttings taken from adventitious or visible bud was affected by presence of the terminal bud. Rooting of softwood adventitious cuttings was significantly greater when apical bud was removed (90%). Second best rooting occurred with adventitious cuttings with terminal (50%). In all cases removal of apical bud increased rooting.

Rooting performance of cuttings from Northern pecan cultivars under intermittent mist using IBA (8,000 ppm, 2 sec. dip) and benomyl fungicide was studied. Significant difference occurred among cultivars; Coy and Greenriver cultivars had highest percentage of rooting (37.5 and 30%). Stark's Hardy had no rooting.