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Flowering Potential of Pecan

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Abstract. **The early-spring mechanical removal of various combinations of buds from one-year-old branches of pecan [*Carya illinoensis* (Wang.) K. Koch, cv. Desirable] increased the number of lateral shoots and indicated the potential for development of both pistillate and staminate flowers and mature nuts from primary, secondary, and tertiary buds from nodes throughout the length of one-year-old branches. 'Desirable' was found to possess strong apical dominance; thus, bud removal and pruning treatments did not greatly increase the development of greater than normal numbers of lateral shoots. Methods that could block apical dominance and allow continued development of young shoots that normally abort appear to have potential of greatly increasing crop productivity.**

Pecan nuts are produced by fruit developing from pistillate flowers borne terminally in clusters on current year's wood, while staminate flowers are produced from the previous year's wood (2). These pistillate flowers almost always develop on shoots arising from the one or 2 primary buds that occupy the most terminal position on the branch (6), while staminate flowers develop from almost all primary and secondary buds except for the true terminal bud (9). Isbell (2) reported that in the case of 'Stuart', pistillate flowers could be produced from both primary and secondary buds but not from tertiary buds of the upper apical nodes of one-year-old branches; however, the flowering potential of buds from lower nodes was not fully assessed. Nor was it determined if flowers from secondary or tertiary buds could develop into mature nuts.

It is not known whether both pistillate and staminate flowers can generally be produced from primary, secondary, and tertiary, etc., buds from nodes throughout the length of the branch; however, staminate flowers are produced from primary and secondary buds from nodes throughout the length of previous year's shoots (7). It is also unknown whether apical dominance in branches is weak enough to allow full development of larger than normal numbers of flowering shoots when subjected to mechanical removal of buds. This information has implications concerning the production of pecan nuts with respect to pruning treatments, manipulation of lateral branching, increased productivity by inducing branching, and the possibility of developing hedge row and high-density cultural methods.

The purpose of this research was to determine the flowering and fruit-set potential of various bud types for 'Desirable' (a very important southeastern cultivar), which is deficient in lateral branching (1), and to determine if bud development could be mechanically manipulated to increase lateral branching and the subsequent production of nuts.

One-year-old branches from five 25-year-old trees of 'Desirable' pecan possessing 10 nodes in which primary, secondary, and tertiary buds (Fig. 1) could be visually identified were selected and subjected to several different bud-removal treatments. Each treatment was applied to 50 or more branches and was replicated on 5 trees, thus giving a randomized complete block design using at least 250 branches per treatment. Treatments consisted of mechanical removal of various combinations of primary and secondary buds while leaving tertiary and quaternary buds (Fig. 2). Treatments were applied immediately prior to budbreak in early March 1981. Buds and branches were observed weekly for 4 weeks and again at nut maturity for flowering, number and growth of branches, and nut set.

The removal of different buds resulted with branches and pistillate flowers developing from different positions and bud types other than normal (Table 1). Removal of primary buds from uppermost nodes induced the dominance of the remaining apical primary bud and its production of pistillate flowers. The removal of 4 (40%) or more of the primary buds shifted production to the most apical secondary bud and it then became dominant or equal in dominance to the remaining apical primary bud. Exclusion of all primary buds resulted in the 2 most apical secondary buds developing branches and flowers. A treatment to simulate tip pruning, in which the upper one-half of the branch plus the remaining apical primary bud were removed, induced the dominance of the apical secondary bud and its subsequent production of pistillate flowers. The absence of all primary and secondary buds from all branch nodes induced lateral branching and pistillate flower development from the 2 uppermost tertiary buds (Table 1). The removal of the entire branch, except for the 3 basal nodes, also resulted with the production of pistillate flowers from primary, secondary, and tertiary buds. Thus, all primary, secondary, and tertiary buds appear to be capable of producing pistillate flowers and such flowers are capable of developing into mature nuts.

Staminate flowers were produced from all primary, secondary, and tertiary buds along the length of the branch (Table 1). They occurred in groups of a) 3 to 4 catkins with 3 stalks per catkin for primary and secondary

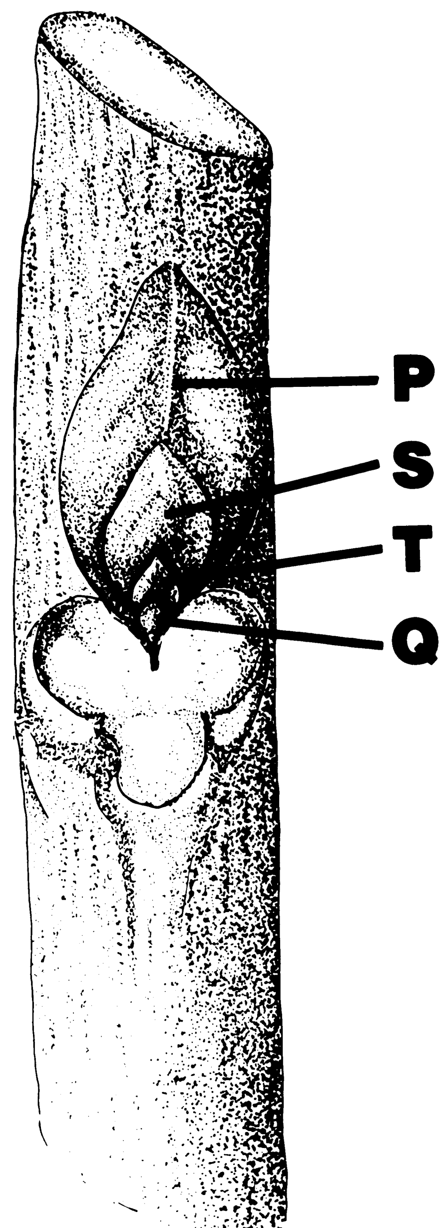

Fig. 1. Bud hierarchy in nodes of one-year-old 'Desirable' pecan branches. Nodes consist of primary (P), secondary (S), tertiary (T), and quaternary (Q) buds.

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Table 1. Effect of bud removal on the bud source of developing pecan flowers.

Buds removed	Bud source of pistillate flowers	Bud source of staminate flowers
None	2 most apical primaries	All primaries and upper secondaries
Most apical primary	Apical secondary and remaining apical primary	"
Most apical primary and secondary	2 most apical remaining primaries	"
2 most apical primaries	2 most apical remaining primaries	"
3 most apical primaries	2 most apical remaining primaries	"
4 most apical primaries	Most apical secondary and most apical remaining primary	"
Upper one-half primaries	Most apical secondary and most apical remaining primary	"
Upper one-half of branch plus most apical primary	Most apical secondary and most apical remaining primary	All secondaries and remaining primaries
All primaries	Two most apical secondaries	Secondaries
All primaries and secondaries	Two most apical tertiaries	Tertiaries

Table 2. Effects of selective bud removal on resulting shoot and fruit growth.

Buds Removed	No. of Shoots	Shoot length (cm)		No. pistillate flower clusters	Mature nuts/cluster
		Major	Minor		
None	1.8 a[z]	15.2[y]	8.9[y]	0.8[y]	1.0[y]
Most apical primary	1.8 a	14.7	9.4	0.8	1.4
Most apical primary and secondary	1.9 a	15.2	9.1	0.9	1.2
2 most apical primaries	1.8 a	15.2	8.6	0.8	1.4
3 most apical primaries	2.0 a	15.0	8.4	0.8	1.4
4 most apical primaries	2.1 a	15.5	9.1	1.0	1.5
Upper one-half primaries	2.6 b	15.2	8.6	0.8	1.3
Upper one-half of branch plus most apical primary	2.0 a	14.8	9.2	0.9	1.1
All primaries	1.8 a	15.0	9.1	0.7	1.0
All primaries and secondaries	1.8 a	14.7	9.1	1.0	1.5

[z]Mean separation in column by Duncan's multiple range test, 5% level.
[y]Values in columns nonsignificant, 5% level.

buds on the apical one-half of the branch and b) 2 catkins with 3 stalks for primary and secondary buds on the lower one-half of the branch and all tertiary buds.

Apical dominance was observed to be very strong in that all buds (primary, secondary, and tertiary) along the one-year-old branch developed with the most apical buds developing faster and competing more successfully than the lower or basal buds. Essentially all primary and secondary buds (except for the extreme basal ones) break naturally, and primary buds are dominant over secondary buds. Since several primary and secondary buds undergo budbreak, there is potential for several lateral branches and thus more pistillate flowers and supporting leaf area; however, these branches naturally develop to only 1–3 cm in length and abscise after pollen anthesis (about 4 weeks of age).

Bud-removal treatments were generally unsuccessful at stimulating greater than normal levels of branching. However, removal of primary buds from the upper one-half of the branch induced the development of more shoots than normal (Table 2). These shoots developed from the 2 apical secondary buds and a 3rd branch from the uppermost remaining primary. There were no differences among other bud treatments. Thus, bud treatments did not affect branch length, number of pistillate flower clusters per parent branch, or mature nuts per cluster (Table 2).

This research expands on that of Isbell (2) and Woodroof (8) and indicates that both pistillate and staminate flowers can be produced from essentially all primary, secondary, and tertiary buds and can produce mature nuts. Thus, despite pruning treatments removing various portions of a shoot, or inclement weather, or pests destroying primary and/or secondary buds, the buds still have the potential to provide both pistillate and staminate flowers sufficient for a 'Desirable' nut crop if the pruning or damage is prior to or shortly after budbreak. It is currently unknown if quaternary buds can produce flowers of any kind.

Attempts to increase pecan yields by using high-density plantings have had limited success because currently available cultivars are vigorous and rapid-growing trees that become crowded and need thinning (by tree removal) before economic returns are obtained. Pruning most of the one-year-old branch growth in winter or early spring may be a means of reducing tree size without a yield loss. 'Desirable' shoot growth and development as controlled by apical dominance is such that no more than 2 shoots (and subsequent flower clusters) per one-year-old branch is generally produced; this indicates that mechanical-pruning techniques to induce additional numbers of lateral shoots may be unsuccessful with 'Desirable'. This supports results of several mechanical-pruning studies in that a significant usable increase in lateral branching has not been obtained with most cultivars (3, 4, 7). These data indicate that the induction of persistent lateral branching in 'Desirable' may be best regulated chem-

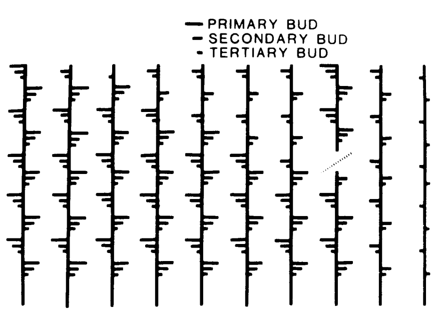

Fig. 2. Debudding treatments consist of mechanical removal of either primary, secondary, or tertiary buds from one-year-old pecan branches. Buds removed were: A) no buds removed; B) most apical primary bud; C) most apical primary and secondary buds; D) 2 most apical primary buds; E) 3 most apical primary buds; F) 4 most apical primary buds; G) upper one-half (50%) of primary buds; H) upper one-half of branch and most apical primary bud; I) all (100%) primary buds; and J) all primary and secondary buds.

ically rather than mechanically and has great potential for both pistillate and staminate flower production. The use of chemical inducers of lateral branching of pecan has already shown potential (5) and should be investigated further with 'Desirable'.

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Root and Shoot Growth of Field- and Container-grown Pecan Nursery Trees Five Years After Transplanting

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Abstract. **Field- and container-grown trees of pecan [*Carya illinoensis* (Wang) K. Koch] were evaluated 5 years after transplanting to the field. Tree survival was 100% with 2-year field-grown and 2-year and 1-year container-grown trees. Trunk height, caliper, and the number of roots were not significantly different for nursery-grown vs. container-grown trees, but roots of field-grown trees grew to a greater soil depth. Container-grown plants had circular and kinked roots, but growth of trees 5 years after transplanting were not affected adversely. Root pruning at transplanting did not influence trunk height and weight, root depth, number of roots, and root weight.**

Failure to transplant nursery, bare-root pecan trees successfully may be due to the lack of adequate lateral root formation. Pecan trees produced in containers may be more costly than field-grown trees (1) and often have kinking and circling roots that may be detrimental to establishment and subsequent growth of trees (9). Root girdling apparently causes tree decline by reducing stem conductivity and radial communication between tissues (4). Root pruning of seedling trees shortly after germination did not reduce tree growth in the nursery, but also did not increase growth after transplanting (5). Root pruning of 4 tree species during transplanting to peat pots and 3.8-liter (gallon) containers more than doubled the number of plants with acceptable root systems, but survival and growth were not affected adversely after one season's growth (3). Tree growth from the bare-root, barrel-grown pecan seedlings was less than that from container-grown seedlings after 2 years (6).

In a 2-year study, pecan trees with taproots pruned to 25 or 50 cm length rerooted better and with a greater survival rate than trees pruned to a 76-cm-long taproot, but root length did not influence shoot length or the number of shoots per tree (7).

The objectives of this study were to evaluate the survival and subsequent growth of transplanted pecan trees. There were 3 comparisons: 1) trees were produced from seed germinated in the field or in containers; 2) trees were root-pruned or unpruned when transplanted; and 3) trees were budded just prior to transplanting or budded one year earlier with one-year-old scions at the time of transplanting.

Pecan seed were planted in the nursery in late February 1975 and 1976 and in containers 28 cm in diameter and 28 cm deep only in 1976 and seedlings were patch-budded with 'Cherokee' the following August. Field-grown trees planted in 1975 (and budded in August 1975) were transplanted to containers in February 1976. One-half of the plants from each growing regime were root-pruned before planting to permanent location on March 2, 1977. This resulted in a 2 × 2 × 2 factorial (field-grown vs. container-grown; 1- vs. 2-year-old rootstocks; and unroot-pruned vs. root-pruned) replicated 6 times using a randomized complete block design. A least-squares statistical analysis procedure (2) was applied because of missing data. Mean dimensions of the root system of unpruned nursery plants were 40 cm wide and 60 cm deep; those for pruned nursery trees were 40 cm wide and 30 cm deep. The root ball of container-grown plants was 28 cm in diameter and 28 cm deep. Container-grown plants were root-pruned by removing about half of each circling root. The trunk length of the budded field and container trees on 2-year rootstocks averaged 175 cm and 102 cm, respectively. The trunks of one-year rootstocks of field and container trees consisted of dormant buds ready for forcing.

The planting holes dug for orchard establishment were 60 cm wide for all treatments and 76 cm deep for field-grown, unroot-pruned trees and 46 cm deep for the remaining treatments. A slow-release fertilizer 18N–3P–10K at the rate of 198 g per tree was mixed with the backfill soil at planting. The trees were irrigated when planted and no additional water was applied. The trees were fertilized with 13N–6P–11K each spring at the rate of 454

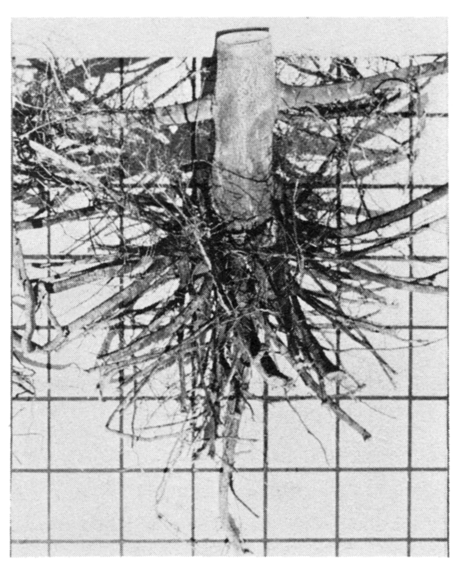

Fig. 1. Roots of a 2-year field-grown, pecan tree; roots were not pruned prior to transplanting.

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