

## 'Elliott' Pecan

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The original 'Elliott' pecan tree [*Carya ilicinoides* (Wangenh.) K. Koch] was a seedling in the lawn of a house in Milton, Fla., purchased by Henry Elliot in 1912. This tree, with a trunk diameter of 0.76 m, was resistant to scab [*Fusicladosporium effusum* (G. Winters) Partridge & Morgan-Jones], and produced up to 114 kg of high quality nuts in good years (5). Mr. Elliot gave some of the nuts to Harlan Farms Nursery, Paxton, Fla. Mr. Harlan was impressed and Mr. Elliot gave him bud wood that he used to establish a 6 ha orchard in 1919. Mr. Harlan sold the orchard to Lee and Otis Mathis and the original 'Elliott' planting remained in the Mathis family. Because of 'Elliott's' resistance to scab and its excellent quality nuts, the Georgia Extension Service began recommending it for orchard planting in the early 1960s. 'Elliott' is widely planted in small acreages in Georgia, with the greatest concentration in the Fort Valley-Perry area. Although the Elliot family spells their name with one "t", the pecan industry usually spells the cultivar name with two "t's" (5).

### Tree characteristics

'Elliott' has a low chilling requirement (16) and is well suited to areas with mild winters. Bud break is early (9,20,32,40,45), so 'Elliott' is not recommended for planting in areas subject to late spring freezes (42,40). The leaf is relatively small, very dark green, and glossy. The veins are raised to an unusual degree which is one of 'Elliott's' most distinguishing characteristics. Normally, leaf retention in the fall is good. A heavy fruit set can cause premature defoliation of 'Elliott' trees, but this is minor compared to other cultivars such as 'Moore'. During prolonged cool au-

tumns, green color retention of the leaves is poor. Tree form is spreading with an open canopy, and fruiting branches are maintained throughout the tree. The canopy is about as broad as high and overall tree size is smaller than 'Stuart' (40).

'Elliott' is protogynous, with stigma receptivity occurring early to very early in the season compared to other cultivars (28,45,48). In the southeastern U. S., 'Desirable', 'Caddo', and 'Pawnee' are good pollinizers for 'Elliott'. Pollen shed of 'Elliott' is midseason. 'Elliott' can pollinate 'Caddo', 'Moreland', and 'Oconee' and is an early pollinizer of 'Desirable'. Nuts mature in midseason, about 3 days before 'Stuart' (40). Shuck dehiscence is exceptionally uniform, in contrast to 'Stuart' which is very uneven (40). The uniform shuck opening allows a once-over harvest, making 'Elliott' particularly adapted for the profitable early retail market. 'Elliott' is harvested in the first or second week of October in most locations in the Southeast (2,33,42).

Pecan trees are usually planted on well-drained soil, but are occasionally planted on moderately well-drained soils. 'Elliott' leaves stay green longer than 'Desirable' leaves when trees are planted on moderately well drained soils (40), and 'Elliott' sometimes is preferentially planted on such sites. 'Elliott' is very susceptible to cold injury, especially when trees have produced an excessive yield. Such damaging events are rare in the southeastern U.S. but happen frequently in some pecan producing areas. Relative to 'Cape Fear' and 'Desirable', Elliott has moderate resistance to high winds, and damage has been relatively minor in hurricanes (40). 'Elliott's' resistance to wind is due to strong crotch angles and an open canopy (3,4). Be-

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cause of the inherent tendency to form strong crotch angles, Elliott requires minimum tree training. Following excessive yields, dieback of some of the smaller branches is common.

Pecan trees are propagated by budding or grafting the scion cultivar onto a seedling rootstock. Each major production region has a favored rootstock seed source, and 'Elliott' is a common choice in the Southeast (24). 'Elliott' is well adapted for this use because the seed is small, making it cheaper when purchased by weight. In addition, 'Elliott' kernels are usually well developed, give a high germination rate (21), and require less stratification than other seed stocks, often germinating during the third month of cold storage (P. Conner, unpublished data). In a test of 30 seedstocks, 'Elliott' seedlings had the largest stem diameter (22). The generally high level of scab resistance in 'Elliott' seedlings reduces the need to control this disease in the nursery. Scions grafted to 'Elliott' rootstocks leaf out early in the spring, which leads to more freeze damage in some years (23). For this reason, 'Elliott' is not suitable as a rootstock in the northern pecan production regions colder than USDA plant hardiness zone 7b.

### Productivity

'Elliott' is not a precocious cultivar (17,34,37,39), especially in comparison to many newer cultivars which were selected for early bearing (44). In a trial in Tifton, Ga., 'Elliott' trees averaged 1.1 kg per tree in the first 10 years after planting, while the standard precocious cultivar 'Cape Fear' averaged 3.5 kg per tree (48). Yields from 'Elliott' were also about 1/3 those of 'Cape Fear' in south Alabama (33). Yield efficiency of young 'Elliott' trees was found to be 28.7 g kernel·cm<sup>-2</sup> trunk cross-sectional area which is only 1/3 of the value of the most efficient cultivars (33).

Long-term yield data from mature pecan trees are scarce, but yield estimates of 'Elliott' are similar to 'Stuart' (1,3,40). 'Elliott' trees have a strong tendency to bear alter-

nately. In Tifton, Ga., mature 'Elliott' trees had an alternate bearing index (I) (13) of 0.68 (smaller number indicates bearing consistency), higher than both 'Desirable' (0.40) and 'Stuart' (0.47). Most cultivars with an alternate bearing index this high are not recommended for production in the Southeast. Limited attempts to control alternate bearing in 'Elliott' by mechanical fruit thinning have been unsuccessful. Following an excessive crop year, 'Elliott', like 'Stuart' and 'Wichita', tends to have a copious pistillate flower abortion (first drop). The first drop is inversely related to shoot vigor (38); consequently, vigorous shoot growth is essential for high yields.

### Nut description and quality

Nut shape is oval with an obtuse base and cuspidate apex (Fig. 1). Often, one shell (pericarp) half is larger than the other. Nuts are round in cross-section. The suture is not elevated, and ridges are not evident. The shell ground color is light brown, smooth, and very sparsely marked with dark brown stripes, but moderately to heavily stippled with dots, especially on the basal end. The shell is not thick, but after nut maturity, it becomes very hard (4,34) and the flavor of the kernel becomes more pronounced.

Nut size of 'Elliott' is small at about 6.3 g (1,2,34,48,50). Kernel percentage is not high, and a good percentage is 53. The relatively low percentage kernel of 'Elliott' reflects its moderate shell thickness plus a moderate percentage fill (48). 'Elliott' is noted for producing good quality nuts and quality normally remains good during years of heavy production, in striking contrast to many alternate bearing cultivars. The small nut size of 'Elliott' may contribute to its ability to maintain quality when crop load is high. Within a genotype, small-volume nuts have higher percentage kernel than large-volume nuts (41). Furthermore, genotypes with large-volume nuts (e.g. 'Stuart', 'Cape Fear', 'Barton') often have poor quality during a heavy "on" year.



Figure 1. 'Elliott' pecan nut and kernel shape and size.

Kernel color is very light or golden (2,33,50). The central partition wall is moderately thin and brittle. Both dorsal and ventral grooves are wide and shallow contributing to the unusually smooth surface of the nut. The shallow grooves and moderately filled nut cavity result in  $\geq 90\%$  of "whole halves" (kernel halves not broken or chipped) (47). Overall, the quality and flavor are excellent. Because of early nut maturity, excellent cracking ability, outstanding color and flavor, and consistent nut quality from year to year, 'Elliott' commands a high price in the market, in spite of its small nut size.

### Pest Resistance

Pecans are attacked by a wide range of disease and insect pests causing substantial losses to the crop. In the humid growing conditions of the southeastern United States, the most economically damaging of these is pecan scab, caused by the fungus *Fusicladosporium effusum*. Scab infection reduces both yield and quality of pecan, and if uncontrolled can result in total crop loss (36). 'Elliott' is one of the few cultivars that is highly resistant to scab in most locations

(3,19,27,33,37). Although scab infections have been reported (20,34,50), they were not severe. Recent wet years in the Southeast have refueled interest in planting scab resistant cultivars such as 'Elliott' (12). Because of its scab resistance, some growers plant 'Elliott' in low-lying areas where poor air drainage enhances scab development.

'Elliott' has been used in several studies to determine the nature of scab resistance in pecan. Wetzstein and Sparks (43) found fewer trichomes on the abaxial leaf surfaces of the resistant cultivars 'Elliot' and 'Curtis' compared to the more susceptible cultivars, 'Desirable', 'Wichita' and 'Schley'. However, microscopic examination of early infection events found that leaf surface morphology was not related to host resistance (49). Yates et al. (49) showed that germ tube and appressoria formation were normal on 'Elliott' leaves, but that the formation of subcuticular hyphae was greatly reduced relative to the susceptible cultivar 'Wichita'. Further studies (8,10,15) indicated that resistance to pecan scab is race-specific, and involves two steps: (i) recognition of fungal subcuticular hyphae and (ii) modification of the intercel-

lular spaces to prevent the spread of the fungus within the leaf. Resistance to pecan scab within a cultivar is usually ephemeral as the fungus eventually adapts to overcome the resistance. Studies showing only intermittent infection (20) since 1925 suggest that the fungal pathogen has not yet well adapted to the resistance of 'Elliott'.

While scab is the major disease in pecan, other pests can be important in some circumstances. In Louisiana, 'Elliott' has good resistance to downy spot (*Mycospharella caryigena* Demaree and Cole), vein spot (*Gnomonia nerviseda* Cole), and bunch disease (*Phytoplasma* in subgroup III) (25,26). In Georgia, the fruit is very susceptible to powdery mildew [*Microsphaera penicillata* (Walroth ex. Fries) Leveille], but the damage from this disease is light (40). 'Elliott' is intermediate in susceptibility to pecan bud moth (*Gretchina boliana* Slingerland) (31) and is resistant to pecan phylloxera (*Phylloxera notabilis* Pergande) (4). 'Elliott' is moderately resistant to black pecan aphids (*Melanocallis caryaefoliae* Davis) in Georgia (46). Foliage condition on unsprayed 'Elliott' trees can be poor because trees are susceptible to yellow aphids (*Monelliopsis pecanis* Bissell) leading to a buildup of sooty mold (*Capnodium* sp.) (18). However, in general and except for black aphids in some years, insects on 'Elliott' are not a major problem. The scab resistance of 'Elliott' and its minor insect problems make it an excellent homeowner tree.

### Genetic analysis

'Elliott' pecan seems to be relatively genetically distinct from most other pecan cultivars. Marquard (29) found 'Elliott' to have a rare b allele for the isozyme phosphoglucomutase. Of the 65 cultivars investigated, only the cultivar 'Brake' shared this allele. Conner and Wood (14) used random amplified polymorphic DNA (RAPD) markers to analyze the genetic diversity of 43 pecan cultivars. Similarity coefficients from this study seem to indicate that 'Elliott' is genetically dissim-

ilar from most other cultivars and it clustered most closely with 'Curtis', which also originated in Florida. Geographically, the origin of 'Elliott' and 'Curtis' may be different from that of other southeastern U.S. cultivars. The Florida industry developed from nuts brought by John Hunt on his way home from the Mexican War and planted in Bagdad, Florida about 1848 (7). Mr. Hunt traveled by ship and the nuts were collected along a river bottom. The large size of the parent 'Elliott' tree in 1912 (5) places it in a time frame closer to the Bagdad planting than to the first plantings in other southeastern states which were established in the late 1800s (27). Bagdad Fla. is only 4 km distance from Milton Fla. where the original 'Elliott' tree was located. The dissimilarity of 'Elliott's genome to more commonly grown southeastern cultivars may be an important factor the durability of its scab resistance as local races of the pathogen may not have been commonly exposed to the resistance genes of 'Elliott'.

'Elliott' has been used as a source of scab resistance in breeding programs (6,35). Roberts et al. (35) found that open-pollinated 'Elliott' seeds gave a large percentage of seedlings with high levels of resistance to leaf scab. We have found in our own breeding work that the resistance level of 'Elliott' populations is highly dependent upon the cross (Table 1). Resistance levels of the progeny tend to be much higher when both parents are resistant as compared to crosses between resistant and susceptible parents. No commercially important cultivars have been released with 'Elliott' parentage, likely because of its small nut size, which is transmitted to a large percentage of its progeny (11). However, because of its widespread usage as a rootstock, it is not uncommon to find seedling trees with 'Elliott' parentage in orchards where the grafted scion has died. A few such seedlings are currently being evaluated as potential new cultivars (P. Conner, unpublished data).

Because of its extensive use in the Georgia pecan breeding program, 'Elliott' was chosen as a cultivar to develop a genetic linkage map

**Table 1.** Leaf scab ratings of 'Elliott' pecan crosses in Tifton, GA in 2003.

Female parent	Male parent	No. seedlings	% #1 rating <sup>z</sup>	Avg. rating <sup>z</sup>
Elliott	Desirable	372	11	3.4
Elliott	Elliott	56	46	2.2
Elliott	Gloria Grande	67	57	2.0
Elliott	Oconee	210	19	3.2
Barton	Elliott	69	80	1.4
Desirable	Elliott	73	8	3.5
Pawnee	Elliott	67	10	3.0

<sup>z</sup>Leaf scab ratings: 1=no scab, 2=small lesions with reduced sporulation, 3=moderate number of large expanding lesions, 4=numerous expanding lesions, stem scab

using amplified fragment length polymorphism (AFLP) and RAPD markers (6). The map was developed based on two seedling populations from the cross 'Pawnee' x 'Elliott'. The 'Elliott' map is comprised of 174 markers in 17 major linkage groups covering 1,698 cM. This map is estimated to cover 57% of the 'Elliott' genome. Loci controlling dichogamy type and stigma color were tightly linked together on linkage group 16.

Although the small nut limits 'Elliott's market and price, its moderate yields of excellent quality kernels and strong levels of scab resistance make it a profitable cultivar in most years.

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