Three-dimensional Characterization of Bearing Pecan Tree

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Abstract. Three-dimensional leaf and fruit distribution was studied in a 26-year-old 'Success' pecan tree [*Carya illinoensis* (Wangenh.) K. Koch]. The tree was typical of the trees in this orchard and typical of thousands of hectares of mature pecan trees growing in a crowded condition. There are fewer leaves and fruit in the lower and central canopy than in the rest of the tree. To obtain an adequate sample, measurements should be taken from branches arising at a height ≥ 4.75 m and from 1.9 m from the center of the tree trunk to the edge of the canopy around the trees. Fruit could be sampled from branches arising at ≥ 3.76 m from the ground and from 3.37 m from the center of the tree trunk to the edge of the canopy around the tree.

Development of sampling methodology to estimate foliage and yield of pecan trees accurately would benefit growers and scientists. Crop estimates are necessary to improve pest management decisions and marketing strategies, and for use in research. Several attempts have been made to estimate the amount of foliage and fruit load by correlating these two characteristics with crown area (Cutler, 1976), trunk circumference (Worley et al., 1972), and cross-sectional area of the trunk and branches (Cutler, 1976). The section of the pecan tree to be sampled has been one of the most important aspects for fruit sampling. Malstrom and Sparks (1973) reported that the major fruiting area of mature 'Schley' pecan trees was the periphery of the canopy and that the percentage of the shoots fruiting and the number of fruits per cluster were greater at 3 to 4 m from the ground than at lower sampling positions.

The experiment was conducted in August when leaves, branches, and trunk were near their maximum stage of development, and fruits were entering the liquid endosperm stage. A 26-year-old 'Success' pecan tree growing on a Riverside seedling rootstock was measured in three dimensions. The tree was located in the Adriance Orchard on the

Texas A&M Univ. Plantation. Tree spacing was 15.2 x 15.2 m on the diagonal, with rows oriented from northeast to southwest and from northwest to southeast. The nearest tree on the north (0°) was 22 m away from the test tree. The nearest tree to the northeast (45°) was 15.2 m away. The same alternate spacing pattern was repeated at 45° increments to complete the circle. This tree was selected because it is typical of trees in the many overcrowded orchards that are in need of sampling for integrated pest management, nutrition analysis, and yield analysis. The tree height was 15 m, the minimum height of the crown was 1.07 m from the ground, and the three main scaffold limbs arose from the trunk at 1.5 to 1.6 m from the ground. The average crown radius was 8.55 m and

Fig. 1. Leaf distribution by height intervals on a bearing 'Success' pecan tree.

Fig. 2. Number of leaves at different horizontal distances from the center of the trunk of a 'Success' pecan tree. Numbers on the x axis represent the midpoint of the interval for distance.

Table 1. Frequency table of branch size classes of a bearing 'Success' pecan tree.

Circumference class (mm)*	Frequency	Cumulative frequency	Percent (%)	Cumulative (%)
12.5-37.5	1	1	0.18	0.18
37.6-62.5	50	51	8.83	9.01
62.6-87.5	134	185	23.67	32.69
87.6-112.5	104	289	18.37	51.06
112.6-137.5	63	352	11.13	62.19
137.6-162.5	52	404	9.19	71.38
162.6-187.5	28	432	4.95	76.33
187.6-212.5	20	452	3.53	79.86
212.6-237.5	19	471	3.36	83.22
237.6-262.5	15	486	2.65	85.87
262.6-287.5	13	499	2.30	88.16
287.6-312.5	7	506	1.24	89.40
312.6-337.5	7	513	1.24	90.64
337.6-362.5	4	517	0.71	91.34
362.6-387.5	8	525	1.41	92.76
387.6-412.5	4	529	0.71	93.46
412.6-437.5	1	530	0.18	93.64
437.6-462.5	5	535	0.88	94.52
462.6-487.5	4	539	0.71	95.23
487.6-512.5	1	540	0.18	95.41
512.6-537.5	2	542	0.35	95.76
537.6-562.5	1	543	0.18	95.94
562.6-587.5	3	546	0.53	96.47

*Branch classes with a circumference >588 mm had a frequency ≤ 2 .

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Fig. 3. Distribution of leaves by 10° interval sectors in a bearing 'Success' pecan tree.

Fig. 4. Number of fruit and leaves at height intervals of a 'Success' pecan tree.

Fig. 5. Fruit and leaf distribution by distance from the trunk of a 'Success' pecan tree. Numbers on the x axis represent the midpoint of the distance intervals.

varied from 7.72 m in the south sector to 10.05 m in the north sector. The trunk circumference, 1 m above the ground, was 1.43 m. The location of all branches was recorded using three-dimensional coordinates to de-

termine leaf and fruit distribution in the tree. These coordinates were height from the ground, horizontal distance from the center of the trunk, and the cardinal orientation of the branches at their attachment point (base)

and at their terminal point (apex). All branches ≥ 2 cm in diameter were tagged and measured (Table 1). Sequential numbers were assigned to every tagged branch starting with 1 for the tree trunk; 11, 12, and 13 for the three main scaffold limbs; etc. The number of leaves and fruit was recorded on all tagged branches. The direction of leaf and fruit orientation was obtained by recording the compass direction of their location in relation to the tree trunk. Branch size was measured by recording their circumference immediately distal to the branch collar at points of branching.

Leaf distribution. The number of leaves on the branches increased with height up to ≈ 7.75 m, and then decreased (Fig. 1). About 10% of the leaves were found from 0 to 4.25 m, the region commonly sampled for various studies because mechanical lifts are frequently unavailable. About 68.4% of the foliage was located on branches arising from a region of 4.76 to 8.75 m in height. Lower branches were not present because they had been lost to the shade patterns imposed by adjacent trees.

Branches arising close to the center of the trunk (up to 1.87 m) had only 4% of the leaves (Fig. 2). Branches having their base at 1.88 to 4.87 m from the trunk contained $\approx 66.5\%$ of the leaf population. Apparently this distribution of leaves is related to the crown volume and shape, since the tallest branches arose from this area. Cutler (1976) reported correlations of 0.84, 0.65, and 0.52 between the total number of leaves and crown volume of 'Desirable', 'Success', and 'Stuart' pecan trees, respectively. The lower canopy, up to 4.25 m from the ground, within a radius of 1.87 m from the trunk was the least dense part of the canopy. Shading from the upper part of the canopy caused the low leaf count in this region. Branches having their attachment point at the north, southeast, and east had the most leaves (Fig. 3). The north and east proliferation of leaves can be explained by the fact that the nearest trees on those quadrants were 22 m away. The lack of compliance with this pattern in other sectors might be explained by the fact that the leaves from some branches might fall in neighboring sectors. The prevailing southwest wind, during the growing season, could have influenced the distribution of the branches, but no study was made on the influence of wind in the orchard.

Fruit distribution. The distribution of fruit related to height was bell shaped (Fig. 4). Only 13.3% of the fruit were < 3.75 m in height. Branches with their attachment point from 3.76 to 7.75 m had 66.6% of the crop. Due to the upward growth of the branches, it was obvious that the largest population of fruit was > 3.75 m from the ground. This fruit distribution agreed with data reported by Malstrom and Sparks (1973), who found that the percentage of the fruiting shoots and the number of fruit per cluster were higher in the upper than in the lower canopy, and that "the final yield cannot be predicted with reasonable accuracy by examining the bottom crop of mature pecan trees."

Fig. 6. Fruit distribution by 10° sectors around a 'Success' pecan tree.

The fewest fruit were found in branches arising from the central area of the tree (Fig. 5), where the fewest leaves were also found (Fig. 2) and light availability was minimal. At least 77.3% of the crop was located from

3.37 m from the trunk to the edge of the crown. The fruit distribution of this tree appeared to support what Malstrom and Sparks (1973) reported, in that the periphery of a 'Schley' pecan tree contained the largest

portion of the crop. There were slightly more fruit in the north, east, and southeast sectors than in the other sectors (Fig. 6). The representative area of mature 'Success' pecan tree to be sampled for leaf and fruit data should be >3.75 m high and from 1.9 m from the trunk to the edge of the canopy around the tree. The ultimate sample would be to take all of the leaves and fruit in this area, but, practically, at least one sample should be taken at 90° intervals around the circumference of the tree.

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