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Journal of the American Pomological Society 59(3):134-140 2005

Tree Setting Depth Affects Wind Resistance in Pecan

DARREL SPARKS[1]

Abstract

Hurricanes Frances, Ivan, and Jeanne inflicted widespread damage to pecan [*Carya illinoinensis* (Wangenh.) K. Koch] trees in Georgia during September 2004. Tree damage was either limb breakage, uprooting, or varying degrees of tree tilting without uprooting. The relationship of degree of tree tilt to setting depth at planting was examined. Trees that were set at the same level at which they grew in the nursery did not tilt. Tilting of trees which had been set at a lower depth ranged from a few degrees from upright to total blow over.

Introduction

During September 2004, major wind damage to pecan trees in Georgia occurred during hurricanes Frances (September 5-6), Ivan (September 15-17), and Jeanne (September 26- 27). In south Georgia, maximum sustained winds reached 29-38 knots with peak wind gusts of 37-59 knots (7). Tree damage was either limb breakage, uprooting of the tree, or varying degrees of tree tilting without uprooting. All types were widespread. Limb breakage was especially severe in 'Desirable' and 'Stuart'. Breakage in 'Desirable' was primarily due to poor crotch angles. In 'Stuart' breakage usually occurred on the mid to distal portion of the branch as most of the weight of the foliage and fruit is located on this portion of the branch. Uprooting was more severe on cultivars with dense foliage as in 'Schley' or with a wide-spreading canopy as in 'Cape Fear' than on cultivars with less dense foliage or an upright growth habit as reported for pecan wind damage in general (10, 12). Additionally, and regardless of cultivar, trees with brace roots positioned asymmetrically around the trunk were more likely to uproot than trees with symmetrically positioned brace roots. Tree tilting or blowing over without uprooting occurred regardless of cultivars and was associated with bending or displacement of the taproot and, when the tree blew over, by breakage or cracking of the taproot. Observations indicated the damage was associated with setting the tree deeper than it sat in the nursery. This study examines the relationship of setting depth at planting to the degree of tree tilt caused by the winds.

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Materials and Methods

The study was conducted in a 36 hectare, 3-year-old 'Desirable' pecan orchard on NILO Plantation near Albany, Georgia. The orchard was planted on a Greenville sandy loam soil (clayey, kaolinitic, thermic Rhodic Paleudults). The trees were irrigated by micro-jet and fertilizer was injected into the irrigation water. Nutrition was tracked biweekly by leaf analysis and fertilizer was applied based on deviations from optimum nutritional values in the leaf (11). Irrigation scheduling was determined by probing for soil moisture with a steel rod (4). These management practices resulted in excellent tree growth with heights of 4.5 m or greater and trunk circumferences of ~20 cm or greater. Tree tilting from the winds was limited mainly to the ridge area of the orchard. This area of ~14 hectares was used for the study. The degree of tree tilt was measured by suspending a weighted string from the straightest portion of the trunk and recording the resulting angle with a protractor. Trees with a visual deviation from vertical were examined for setting depth. Setting depth was the length of the trunk set below the soil surface at planting, measured from the soil surface line mark on the trunk to the graft union. Trees with brace roots partially exposed on the soil surface served as controls. The trunks of these trees were set at the same position relative to the soil surface as in the nursery or else 1-2 cm below the soil surface. This setting depth was designated "soil surface" and, for statistical calculations, the setting depth was indicated by a zero. Trunk circumference, measured 60 cm above the graft union, was used as the index of tree size. Data were collected October 7 (photographs) and 10 days (numerical data) following the last hurricane, Jeanne.

Results and Discussion

The most common effect from the hurricanes was a wallowed-out basin at the base of the tree created by the tree trunk swaying in the wind (Fig. 1). In most cases, wallowing did not result in the tree tilting which was

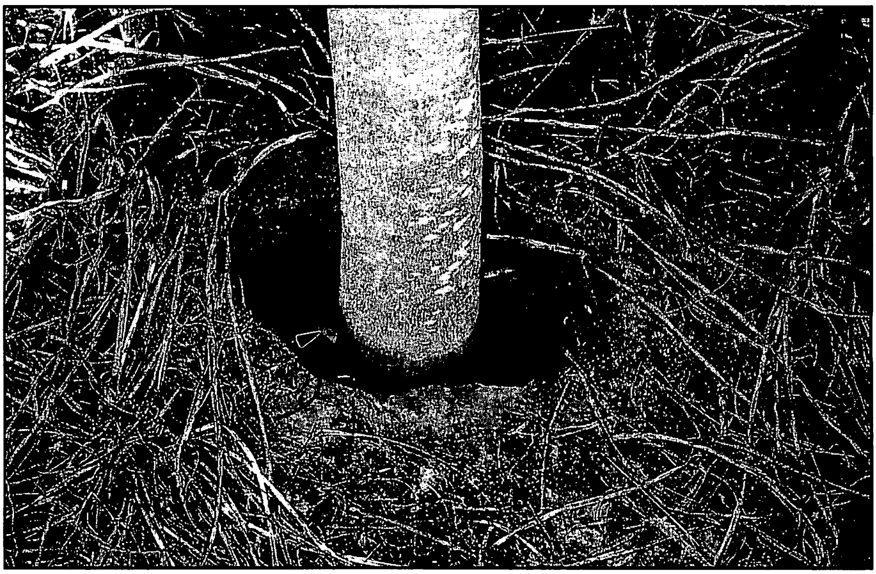

Fig. 1. A pecan tree set too deep at planting. The wallowed-out basin at the tree base was created by the tree trunk swaying in the winds. Note the weak lateral root (triangle).

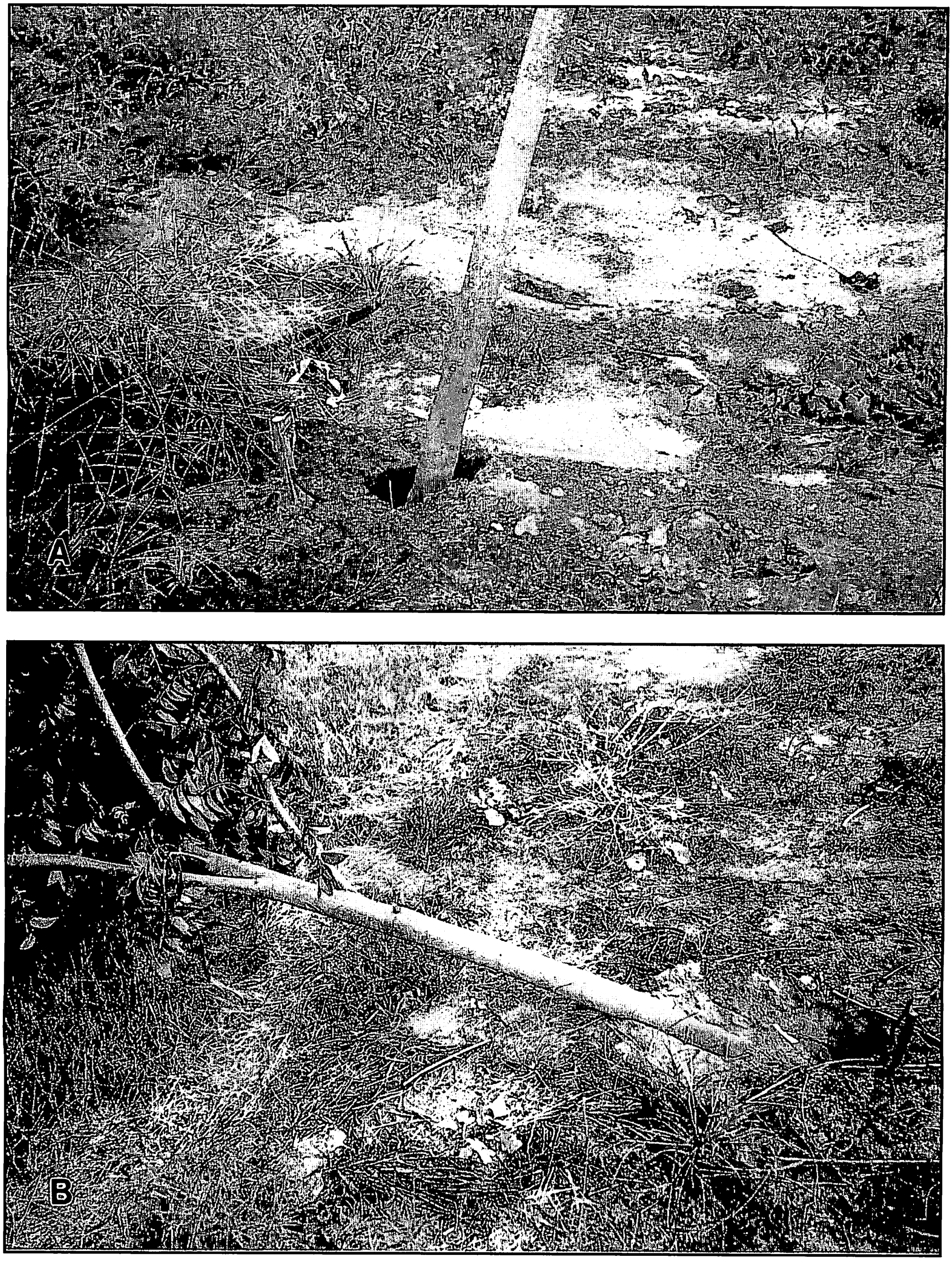

Fig. 2. Pecan trees set too deep at planting. (A) Tree tilting a few degrees from vertical; (B) tree blown over but not uprooted. Note wallowed-out basins.

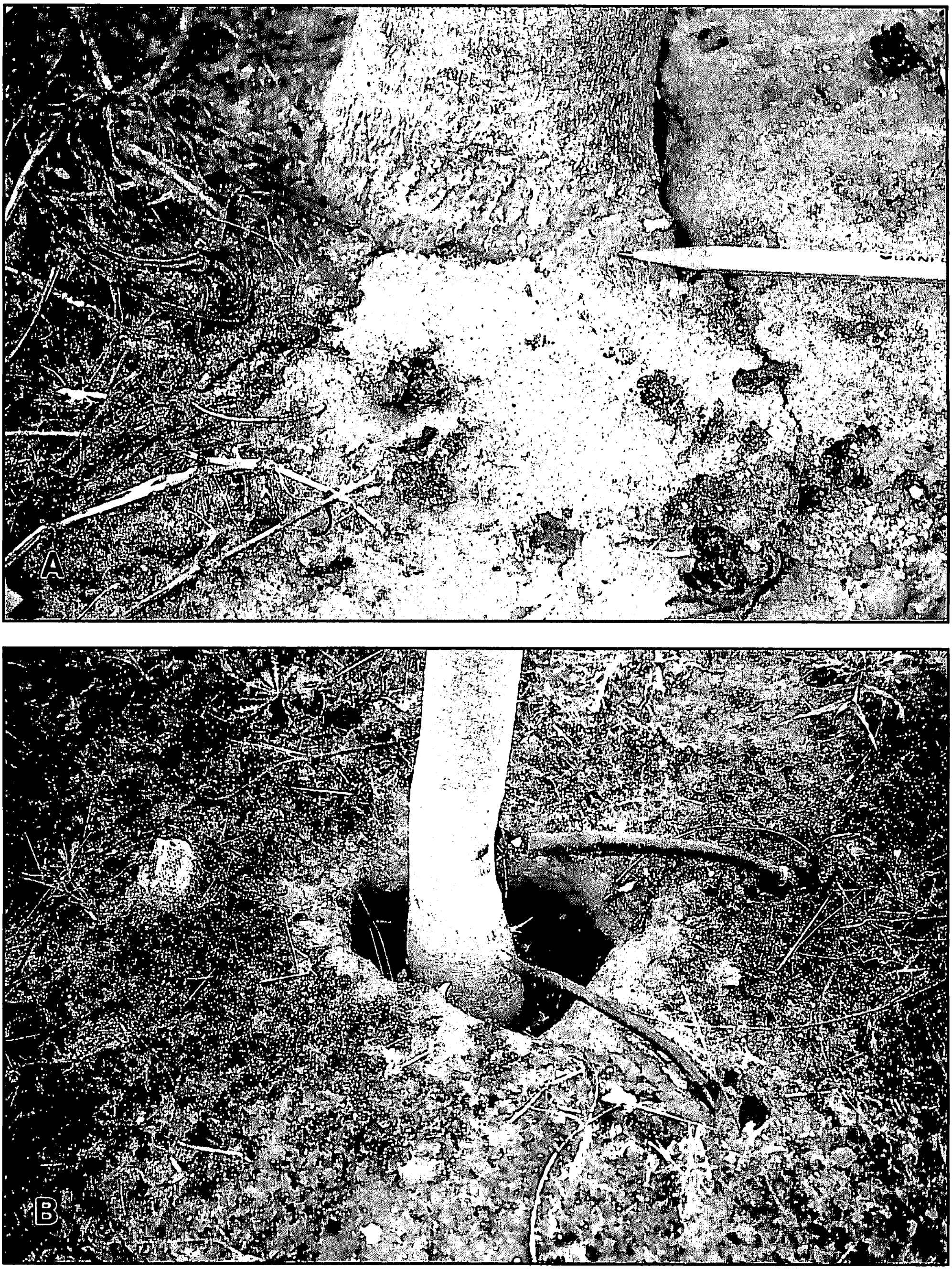

Fig. 3. Control trees. At planting, these pecan trees were set at the same depth as they sat in the nursery. (A) Well-developed brace roots; (B) weakly developed brace roots and a wallowed-out basin. In B, the weakly developed brace roots were pulled from below ground and one root broke away from the taproot.

apparently due to the development of subsurface lateral roots as in Figure 1. However, tree tilting was always associated with wallowing. Tree tilt ranged from a few degrees from vertical (Fig. 2A) to those in which the tree blew over (Fig. 2B). Control trees with brace roots near the soil surface did not wallow (Fig. 3A), with one exception (Fig. 3B). This tree differed from the other control trees in that the brace roots were undersize and were pulled above ground and one lateral root broke away from the taproot.

Tree tilt (Table 1) was not significantly correlated with trunk circumference ($r^2 = 0.06$, $P \leq 0.05$). Tree tilt (Table 1) increased with setting depth ($r^2 = 0.54$, $P \leq 0.05$). Trees that tilted were set 6 cm or deeper than they sat in the nursery. Trees set 20 to 34 cm blew over (Fig. 2B). Between setting depths of 6 to 18 cm the degree of tilt was variable from tree to tree. The wide variance was probably due to variation in the degree of lateral root development from tree to tree at a given setting depth. On trees with wallowed-out basins, subsurface laterals were weak (Fig. 1). Weak laterals failed to hold the tree in place even when the tree was set correctly (Fig. 3B). Weak laterals develop from planting trees with taproots that have minute laterals, termed "carrot" roots. In some pecan nurseries, carrot roots are common. The data (Table 1) confirm the pomological principle governing tree planting; that is, trees should be set about the same depth as they grew in the nursery (3). The same has been demonstrated for apple trees (6).

Improper setting depth remains a problem as trees age because pecan trees do not develop roots from below ground portions of trunks. Consequently, older trees set too deep were subject, like the young trees in Table 1, to blowing over during the 2004 hurricanes (Fig. 4). The exposed lateral root in Figure 1 was undersize and dead. During mid summer 2004 and before the September hurricanes occurred, scattered pecan trees died in some Georgia pecan orchards. Two of these orchards, one located in Marshall and the other in Cordele, Georgia, were examined. Trees in the Marshall orchard either died on one side or else the entire tree died. The trees were correctly set at planting. Partially dead trees had brace roots on the live but not on the dead side. Trees that died totally did not have brace roots. In either situation, digging revealed that subsurface lateral roots beneath areas without brace roots were dead as in Figure 4. In the Cordele orchard, which was planted in a very sandy soil, scattered trees either declined or died. These trees were set too deep as indicated by absence of brace roots and by digging. Trees with visible brace roots did not die or decline. Although pecan trees occasionally die regardless of the year, mainly from being set too deep, the unusually high incidence of tree decline and death in 2004 may have been triggered by the exceptionally wet growing season in 2003. Up to 2004, tree growth in the Marshall and Cordele orchards was excellent. Both orchards had been planted shortly before or following the last excessive wet growing season which occurred in 1991. These observations suggest that the brace roots and accompanying abundance of smaller roots near the soil surface are essential for tree survival during exceptionally wet growing seasons. The significance of near-surface roots is also suggested by tree decline on native sites following river flooding that changes the topography via scouring and deposition (2) and by pecan's sensitivity to water logging in general (1, 5, 8, 9). Consequently, the practices of filling wallowed-out basins with soil or sand or pulling tilting trees to a vertical position and then bracing the trees by piling large volumes of soil around the trunks are doubtful long-term corrective practices for trees set too deep at planting.

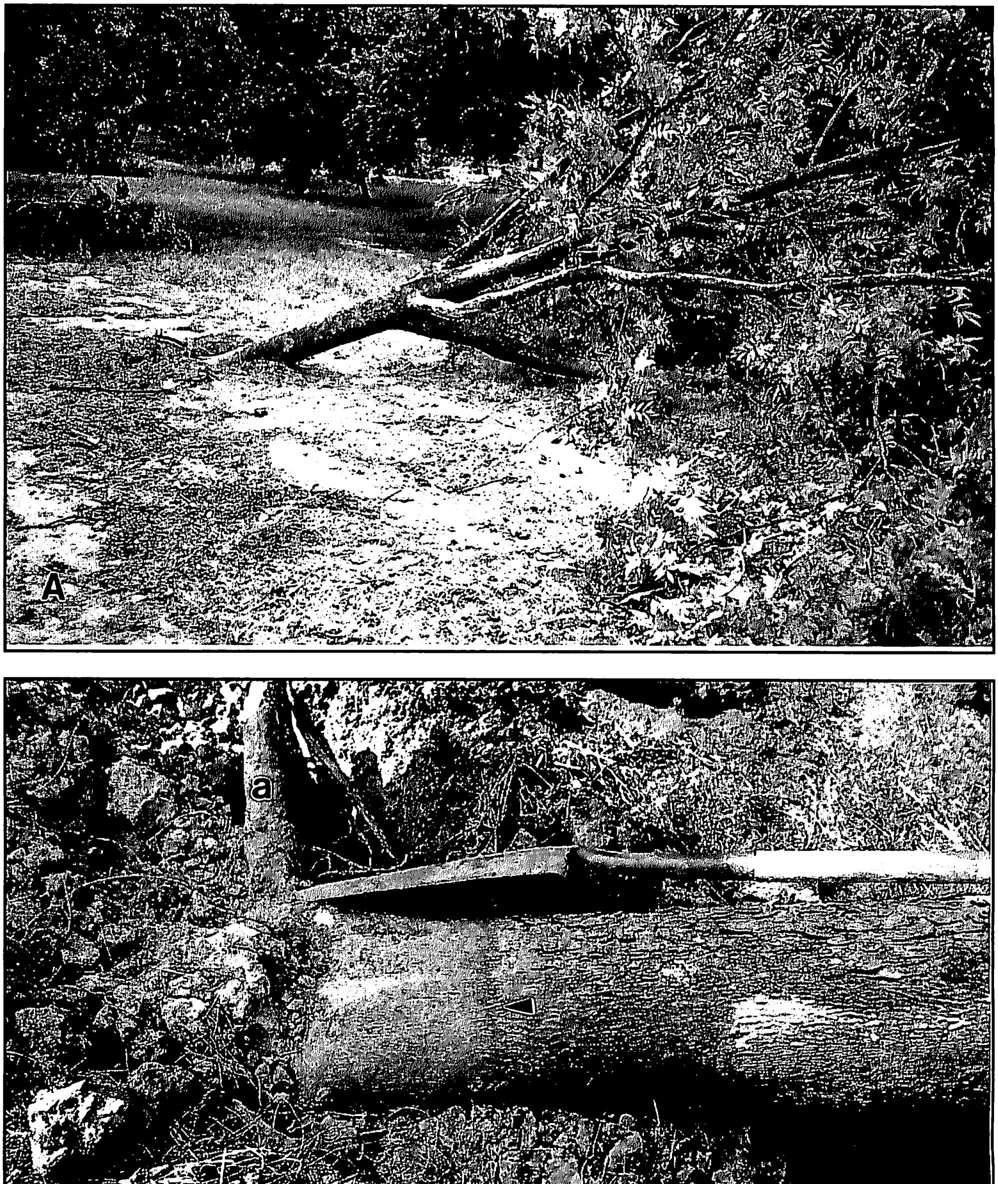

Fig. 4. (A) A ~20-year-old pecan tree (trunk circumference 91 cm) that blew over without uprooting due to being set too deep (B) at planting (i.e. 28 cm too deep). The exposed subsurface lateral root (a) in B was dead. Note the soil surface line mark (triangle).

Table 1. Degree of tilt of pecan trees following hurricanes Frances, Ivan, and Jeanne vs. setting depth at planting and trunk circumference.

Tree setting depth -cm[1]	Trunk circumference -cm	Tree tilt- degrees from vertical
Soil surface	19	2
Soil surface	20	1
Soil surface	22	0
Soil surface	22	0
Soil surface	23	0
Soil surface	24	3
6	22	61
8	23	8
9	22	29
10	22	6
10	24	55
11	20	25
11	23	7
13	22	7
13	24	10
15	21	9
15	24	41
17	22	10
17	25	30
18	24	35
20	24	72
25	27	86
34	18	86

[1]Setting depth is the length the trunk was set below the soil surface at planting, measured from the soil surface line mark on the trunk to the graft union.

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