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Drought Stress Induces Fruit Abortion in Pecan

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Abstract. **Fruit abortion in three cultivars of pecan [*Carya illinoensis* (Wangenh.) C. Koch] was compared during the 1986 drought. Fruit abortion in 'Caddo', 'Western', and 'Cape Fear' was, respectively, 36, 28, and 6 times greater from drought-stressed than from irrigated trees. These results may reflect cultivar differences in drought tolerance and/or differences in available soil moisture. The data also suggest that the third fruit drop in pecan is sensitive to water stress.**

Prolonged drought stress can induce fruit abortion in pecan (2). This conclusion was based on subjective visual ratings and on the assumption that drought stress decreased with soil depth. The abortion occurred within the first 2 weeks of June. This interval closely coincides with the second of four abortion periods that occur during pecan fruit development (5). The extended and severe drought of 1986 provided a opportunity to observe the effect of drought stress on abortion during a more advanced stage of pecan fruit development. The purpose of this study was to quantitate the effect.

The study was conducted during July 1986 in drip-irrigated pecan orchards near Sandersville, Ga. The average monthly rainfall for 1 Jan–22 July in this area and the rainfall for this same period in 1986 is shown in Table 1. The rainfall deficit for this period during 1986 was 410 mm. During the 1986 growing season, the orchards were visited at 10-day intervals or less, beginning 27 Apr. or about the time of pistillate anthesis. By 12 July, an abnormal number of fruit aborted. The magnitude of abortion varied greatly from tree to tree. Examination of the drip systems indicated that the emitters were operative on some trees, but not on others. Greater abortion was apparent from trees with nonfunctional emitters. Counts were made to substantiate these observations.

Nine-year-old trees of 'Caddo', 'Cape Fear', and 'Western' pecan, with and without functional emitters, were selected for counts of aborted fruit. The number of single tree pairs were 6, 6, and 7 for 'Caddo', 'Cape Fear', and 'Western', respectively. Within a cultivar, pair selection was based on proximity of trees with and without functional emitters and similarity of tree size. Accumulative abortion (from about 12 July) was measured on 22 July as number of aborted fruit on a given soil surface area under the tree canopy. Fruits within four areas (0.0625 m^2 each) located 1 m from the tree trunk and at 90° to each other were counted per tree.

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Also on 22 July, 60 firmly attached fruits were removed per tree. The fruits were oven-dried at 70°C for 72 hr prior to weighing. 'Caddo' trees were growing in a Marlboro sandy loam that had been irrigated for ≈1 year and 'Cape Fear' and 'Western' were in a Fuquay loamy sand that had been irrigated for ≈5 years.

Fruit abortion from nonirrigated trees was substantially greater than from irrigated trees (Table 2), indicating that drought stress can induce abortion in pecan. Dry weight of healthy fruit from nonirrigated trees was less than those from irrigated trees, which further substantiates drought stress. Abortion in 'Caddo', 'Western', and 'Cape Fear' was, respectively, 36, 28, and 6 times greater from nonirrigated than irrigated trees. Fruit growth on nonirrigated trees compared to irrigated trees was suppressed 56%, 39%, and 30% for 'Caddo', 'Western', and 'Cape Fear', respectively. The difference among cultivars may suggest differential drought tolerance, as exists among other pecan cultivars (2). In addition, the cultivar response may also reflect differences in available water between the two soil types or, in the case of the Fuquay soil, differences in rooting depth, and thus soil moisture.

Although some abortion occurred from irrigated trees, this was probably not due to lack of sufficient irrigation, as there were three emitters per tree scheduled to operate 12 hr/day with a volume of 7.6 liters·hr^{-1}. Most likely, the abortion is the third fruit drop. This is supported by the fact that both calendar date and fruit developmental stage correspond with those of the third drop (5). Furthermore, abortion from irrigated trees was relatively low, as is characteristic for the third drop. The enhanced fruit abortion from nonirrigated trees (Table 2) suggests the third drop is sensitive to water stress.

Defoliation was not induced by the moisture stress; this indicates that, at this point of development, fruit abortion is more sensitive to drought stress than leaf abscission. The greater sensitivity of the fruit to moisture stress may indicate an adaptive survival mechanism. In pecan, kernel development is an exhaustive process (4) characterized by photosynthate stress (1, 3). Fruit abortion prior to kernel development would minimize fruit-

Table 1. Average and 1986 rainfall at Sandersville, Ga.

	Rainfall (mm)							
	January	February	March	April	May	June	July[z]	Total
Average[y]	113.8	117.3	130.8	94.0	97.5	105.9	77.5	736.8
1986	52.1	68.3	65.5	17.0	45.0	54.6	24.1	326.6

[z]Includes rainfall for 1–22 July only.
[y]Based on 24 years of rainfall records.

Table 2. Effect of irrigation during drought stress on fruit abortion and fruit growth in three pecan cultivars, 22 July.

Irrigation status	Fruit abortion (no./m² soil surface)[z]	Fruit wt (g/fruit)
	Caddo	
Nonirrigated	47.3	0.33
Irrigated	1.3	0.77
	Western	
Nonirrigated	79.4	0.62
Irrigated	2.8	1.02
	Cape Fear	
Nonirrigated	44.0	0.58
Irrigated	7.3	0.83

[z]Analysis of variance was on square root-transformed data. Statistical significance: Within each cultivar, fruit abortion and weight/fruit are different at the 0.05 level.

ing stress and thus total stress (drought plus fruiting) on the tree. However, our observations indicate that drought stress conditions in September often induce leaf abscission but not fruit abortion. In September, the kernel is rapidly developing (1). Apparently, by this stage of fruit development, reproduction by seed takes priority over tree survival.

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Water Management during Tall Fescue Establishment

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Additional index words. *Festuca arundinacea,* evapotranspiration, lysimeter, seedling, hydrophilic polymer, turfgrass

Abstract. **Field and greenhouse studies were conducted to determine effects of deficit irrigation and pre-plant soil incorporation of a hydrophilic polymer on the establishment of 'Rebel' tall fescue. In the field, lysimeters containing a sandy clay loam soil were seeded with tall fescue and irrigated with equivalents of 50% or 100% of the potential evapotranspiration (ET_p) (i.e., water used when soil moisture is not limiting) of a mature turf. The low irrigation level resulted in poor germination and stand establishment. Pre-plant incorporation of a hydrophilic polymer (98 $kg \cdot ha^{-1}$) was ineffective in enhancing seedling survival under dry soil conditions. Greenhouse studies evaluating higher levels of polymer application on tall fescue establishment during drought revealed that the polymer did not reduce plant stress until occupying at least 1.0% of the soil volume to a depth of 12.5 cm. Excessive polymer amounts would be required to achieve this proportion in the field.**

Irrigation is often required to achieve satisfactory turfgrass seed germination and stand establishment in arid and semi-arid regions of the United States. Although extensive work has been done to determine water use rates of mature warm- and cool-season turfgrass species (3, 5, 7), little information is available on water requirements of turfgrasses as they develop from seed to maturity. Too much or too little water is often applied after seeding; either may result in poor stand development.

Tall fescue has been recognized for its drought-resistant characteristics as a mature plant (5). Information on water requirements during tall fescue establishment, however, is limited, and would be valuable for improving seedling growth and conserving water.

Generally, it has been recommended that seedbeds remain moist during establishment. In low-maintenance turf areas, where irrigation is not readily available, this is often difficult. Furthermore, water restrictions during dry periods can limit water availability. Deficit irrigation, application of water in amounts less than ET_p, has been evaluated on mature turfgrasses (4, 5); however, effects of deficit irrigation on turfgrass establishment have not been determined.

There has been some interest in the use of hydrophilic polymers as soil amendments and seed coatings to increase plant water availability. Most of the work using hydrophilic polymers has been done with species other than turfgrass (1, 6). However, hydrophilic polymers used as seed coatings for Russian wildrye (*Elymus junceus* Fisch.) grown in a vermiculite medium did not aid germination when employed over a wide range of soil matric potentials (2).

The objectives of this research were to: 1) evaluate the effect of deficit irrigation on tall fescue establishment; and 2) study the effectiveness of amending soil with a hydrophilic polymer to enhance tall fescue germination and seedling survival during drought.

These studies were conducted during 1985 and 1986 at the Colorado State Univ. Plant Environmental Research Center in Fort Collins. Lysimeters (254 mm in diameter by 154 mm in height), described in detail by Feldhake et al. (3), were used to determine ef-

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