Journal American Pomological Society 57(4):142-146 2003

Pecan Tree Dieback Following 1999 -2002 Drought Associated with September Rainfall

DARRELL SPARKS[1]

Abstract

During spring 2002, after three years of drought, tree dieback occurred on pecans [*Carya illinoinensis* (Wangeh.) C. Koch] in Georgia. Dieback severity varied by location within the state. Dieback was visually rated in mid-May 2002 as none, mild, or severe. Degree of dieback was compared with the sum of rainfall departures from normal for 1999 to March 2002. Rainfall departures were calculated by location on an annual basis, for the dormancy period, and individually for progressive stages of tree and fruit development. Dieback was correlated only with rainfall departures occurring during the period of kernel filling. During kernel filling, rainfall was 307 mm above normal in the area with no dieback, 124 to 200 mm above normal in areas with mild dieback, and near normal in areas with severe dieback. These data suggest that effects of severe drought can be greatly negated if rainfall is substantially above normal during kernel filling. These data also suggest that irrigation during the stress of kernel filling may be especially critical and, if irrigation allocations become restricted in the southeastern United States, irrigation during kernel filling may produce greater profits and better tree vigor than at any other single time of the year.

Introduction

A major drought occurred in the southeastern United States from 1999 to September 2002. During spring 2002, branch death occurred in the tops of some pecan trees. Severity of dieback varied from south to north Georgia. The purpose of this study was to determine whether a relationship existed between dieback severity and rainfall during developmental phases of the pecan tree.

Materials and Methods

Dieback was visually rated in mid-May 2002 as none, mild, or severe. Trees in the none category had no visibly dead branches but shoot growth in the tree tops was suppressed resulting in a thin appearance of the upper canopy. On trees in the mild category, dieback was mainly limited to one-year-old branches. Dieback did not occur on all trees. In the severe category, dieback symptoms were relatively consistent among trees and extended into 6-year or older branches (Fig. 1).

Mature trees were rated at Dawson (lat. 31°47'N, long. 84°27'W), Montezuma (lat. 32°17'N, long. 84°02'W), Fort Valley (lat. 32°34'N, long. 83°52'W), Forsyth (lat. 33°01'N, long. 83°57'W), Athens (lat. 33°57'N, long. 83°20'W), and Commerce (lat. 34°16'N, long. 83°29'W), Georgia. Ratings were restricted to non-irrigated trees growing on abandoned home sites, roadsides, and in abandoned orchards. The ratings were consensus of observations of multiple trees (40 or more) in each location. Dieback in spring 2002 was assumed to be a culmination of three consecutive drought years. For this reason, degree of dieback was compared with the sum of rainfall departures from normal for 1999 to March 2002. Rainfall departures were from recording stations (5) located in close proximity to the towns.

Rainfall departures were calculated for varying time spans that were (1) annual, (2) November to March, (3) April to September, (4) April to May, (5) June, (6) July and August, (7), September, and (8) October (Table 1). Except for annual, selection of these time spans was based on the developmental phases of the pecan tree. Growth at these geographic locations is dormant from November to March. During this time, fall and winter rains normal-

[1]Department of Horticulture, University of Georgia, Athens, GA 30602

Figure 1. Response of pecan trees following the 1999-2002 drought in Georgia. A) irrigated tree with no dieback; B) no dieback but thin foliage of a non-irrigated tree; C) mild dieback limited mainly to 1-year-old branches of a non-irrigated tree; and D) severe dieback extending into 6-year or older branches on a non-irrigated tree.

ly replenish the soil profile moisture. April to September is the principal growing season for pecan. In April and May, the spring flush of shoot and leaf growth occurs (2), June coincides with early fruit elongation (6), July and August coincide with major fruit expansion (10), and September encompasses most of the kernel filling period (2). Fruit maturation occurs in October and, usually, October is the last significant month of the growing season.

Results and Discussion

Dieback was not correlated with annual rainfall. Annual rainfall departures in Dawson, Montezuma, and Commerce were similar at -523 to -589 mm (Table 1). In spite of the similar rainfall deficit,

dieback was radically different. Dieback was mild in both Dawson and Montezuma, but severe in Commerce.

Fall and winter rains occurring from November to March did not account for dieback severity (Table 1). Pecan trees in the Fort Valley area did not have dieback. However, areas with lower and with similar winter rainfall deficits to Fort Valley had dieback.

Dieback was not correlated with rainfall during the major portion of the growing season of pecan from April to September (Table 1). Dieback was severe in Commerce, yet rainfall was sightly above normal. Likewise, trees in Forsyth and Athens had severe dieback, but had rainfall deficits of -632 and -272 mm, respectively.

Dieback was not correlated with rainfall during the spring flush of growth occurring in April and May (Table 1). Dieback was mild in Dawson and Montezuma, but severe in Athens despite all three areas having similar rainfall deficits.

Rainfall during early fruit elongation (June) was the only period during which rainfall was above normal at all locations (Table 1). Dieback was poorly correlated with rainfall; Athens and Commerce, with severe tree dieback, had substantially higher above-normal rainfall than other areas. Similarly, dieback was not correlated with rainfall departure during fruit expansion (July and August). Athens and Commerce had normal or above normal rainfall and severe dieback; whereas, rainfall in other areas was in deficit. Only during the period of kernel filling (September) were rainfall departures correlated with tree dieback. Rainfall departure was highest (i.e., wettest) in the area with no dieback (Fort Valley), intermediate in areas with mild dieback (Dawson and Montezuma), and lowest (i.e., driest) in areas with severe dieback (Forsyth, Athens, and Commerce). Rainfall was 307 mm above normal in the area with no dieback, 124 to 200 mm in areas with mild dieback, and near normal in areas with severe dieback.

Data in Table 1 suggest that tree dieback following the severe 1999 -2002 drought was induced by differences in rainfall during the kernel filling period. Furthermore, these data suggest that the effects of a severe drought can be greatly negated by above normal rainfall during the kernel filling period. The apparent relationship between dieback and rainfall during kernel filling is as might have been anticipated. Kernel filling is the most stressful stage of fruit development (2); over-fruiting in very prolific cultivars can result in dieback or tree death (3), and kernel development stress is apparently accentuated by soil moisture deficit (9). Additionally, September is normally the second driest month of the year in Georgia and in about 50% of the years there is insufficient rainfall for optimum kernel development (8).

Table 1. Pecan tree dieback vs. rainfall departure from normal for selected areas in Georgia during the 1999-2002 drought.

		Rainfall departure (mm)[a]							
Location	Tree dieback[b]	Annual	Nov.-Mar. (dormant)	Apr.-Sept. (growth season)	Apr. & May (spring flush)	June (fruit elongation)	July & Aug. (fruit expansion	Sept. (kernel filling)	Oct. (nut maturity)
Fort Valley	None	-368	-554	152	-234	99	-20	307	-64
Dawson	Mild	-523	-445	-259	-302	132	-213	124	-89
Montezuma	Mild	-569	-442	-318	-295	41	-264	200	-58
Forsyth	Severe	-1085	-556	-632	-363	56	-343	18	-84
Athens	Severe	-828	-536	-273	-323	257	3	-10	-140
Commerce	Severe	-589	-569	36	-257	241	61	-13	-137

[a]Rainfall departures are total for the three year period, 1999 to 2001, except for November to March which includes 2002.
[b]Ratings of tree dieback were made in mid-May 2002.

In the southeastern United States, near maximum kernel filling is associated with 32 mm of rain per week during the first half of September (7). During the 1999-2002 drought, average weekly rainfall for the first half of September for Fort Valley, Dawson, Montezuma, Forsyth, Athens, and Commerce was 50, 28, 18, 25, 15, and 15 mm, respectively. Thus, according to this standard only Fort Valley had sufficient rain for maximum kernel filling. Under arid conditions, the calculated water requirement for the pecan tree, as a whole, during September is 51 mm per week (4). Similar calculations for Georgia show that for severe drought areas the tree's average water requirement in September from 1999 to 2001 was also 51 mm per week. During the 1999-2002 drought, average weekly rainfall in September for Fort Valley, Dawson, Montezuma, Forsyth, Athens, and Commerce was 37, 25, 29, 21, 21, and 23 mm, respectively. With respect to the tree's water requirement in September, all locations were deficient in rainfall even though rainfall was near or above normal. Although no dieback occurred in Fort Valley, the upper canopy was thin (Fig. 1) suggesting 37 mm of rain per week in September was inadequate for optimum tree growth and productivity.

The normally dry Georgia September where pecan is not native contrasts with the wetter Texas September where pecan is native (10). Higher September rainfall in its native areas increases species fitness via well-filled seeds and maintenance of tree vigor.

Normal annual rainfall for Fort Valley, Dawson, Montezuma, Forsyth, Athens, and Commerce is 1134, 1267, 1160, 1247, 1263, and 1365 mm, respectively; normal rainfall in September is respectively 71, 91, 67, 77, 85, and 92 mm. Normal annual rainfall and September rainfall in areas with severe dieback (Forsyth, Athens, and Commerce) are higher than in the area with no dieback, Fort Valley. Thus, the association of dieback with rainfall in September (Table 1) was not due to an accentuation of differential normal rainfall among study areas.

The data in Table 1 have apparent implications for pecan irrigation in the humid southeastern United States. Soil moisture appears to be especially critical during the period of kernel filling, as also indicated by other work (9). Normal rainfall in September in Georgia is inadequate for optimum tree performance. Although the tree's water requirement varies with evapotranspiration, maximum water requirement appears to be near 51 mm per week during September. Thus, if irrigation allocations become restricted, maximizing irrigation during kernel development may produce greater economic returns and better tree vigor than maximization at any other time of the year. In years with rainfall deficits in June and July, restricting irrigation to September will result in small nuts (10) but they are more likely to be well filled (1, 7). In years with normal and above normal rain in June and July, nut volume will be average and above average respectively. Under these conditions, maximizing soil moisture in September is essential because a large volume nut is more difficult to fill with kernel than a small volume nut (11).

Literature Cited

1. Alben, A. O. 1957. Results of an irrigation experiment on Stuart pecan trees in east Texas in 1956. Proc. Texas Pecan Growers Assn. 36:23.
2. Davis, J. T. and D. Sparks. 1974. Assimilation and translocation patterns of carbon-14 in the shoot of fruiting pecan trees, *Carya illinoensis* Koch. J. Amer. Soc. Hort. Sci. 99:468-480.
3. Hunter, J. H. and H. E. Hammar. 1948. Nutritional deficiencies associated with poor filling of pecan nuts. Proc. Southeastern Pecan Growers Assn. 41:16-35.
4. Miyamoto, S., J. Henggeler, and J. Benton Storey. 1995. Water management in irrigated pecan orchards in the Southwestern United States. HortTechnology. 5:214-218.
5. National Climatic Data Center. 1999-02. Climatological data for Georgia. Natl. Oceanic Atmospheric Admin., Asheville, N. C.
6. Sparks, D. 1986. Pecan. pp.323-339. In: S.P. Monselise (ed.). Handbook of fruit set and development. CRC Press, Inc. Boca Raton, Fla.

7. Sparks, D. 1992. Pecan cultivars - The orchard's foundation. Pecan Production Innovations, Watkinsville, Ga.
8. Sparks, D. 1995. Kernel development in pecan - A function of soil moisture. Annu. Rpt. Northern Nut Growers Assn. 86: 116-118.
9. Sparks, D. 1996. A climatic model for pecan production under humid conditions. J. Amer. Soc. Hort. Sci. 121:908-912.
10. Sparks, D. 2000. Management of pecan nut growth. Annu. Rpt. Northern Nut Growers Assn. 91:35-50.
11. Sparks, D. 2003. Effect of topography, crop, and irrigation on pecan nut volume and percentage kernel. Annu. Rpt. Northern Nut Growers Assn. (In press).

Journal American Pomological Society 57(4):146-148 2003

Effect of Transplanting Rootstocks Before Grafting on Xylem Exudation and Graft Success in Walnut

KENAN YILDIZ[1] AND HÜDAI YILMAZ[1]

Abstract

The effect of transplanting seedlings before grafting on xylem exudation of seedlings and graft success was studied in early spring grafts of walnut under uncontrolled conditions. Scions of 'Yalova-1' walnut were grafted by the whip and tongue method on one- and two-year-old walnut (*J. regia* L.) seedlings on two dates (15 March and 15 April). Transplanting seedlings did not affect either the amount of xylem exudate or the graft survival on the earlier date (March 15), but decreased the xylem exudation and increased graft survival of two-year-old rootstocks on the later date (April 15). On this date, graft survival percentage of two-year-old rootstocks was increased 20% in 2000 and 25% in 2001 by transplanting seedlings. Xylem sap exudate of two-year-old seedlings - regarded as one of the negative factors for graft success in walnuts, was decreased 2.0 ml in 2000 and 1.3 ml in 2001 by transplanting seedlings before grafting.

Introduction

Walnut (*J. regia* L.) is one of the nut crops gaining in importance in the world. Grafting is still the most common vegetative propagation method for walnut, but there are some problems that may hinder the advancement of good cultivars.

Encouraging progress of grafting technique for walnut has been made in recent years. However, the graft survival percentage of walnut may be low and unstable. Some researchers consider that one of the main factors affecting grafting success is xylem exudation (1,4,5,6,7, 10, 11).

Xylem sap exudation, often called bleeding, occurs in other fruits species such as grape, chestnut and hazelnut, but the bleeding is more severe in walnut than other species. Xylem sap exudation results from root pressure and is increased by rising soil temperature and humidity in the spring (3,4,5,6)

According to Prataviera et al. (7), the existence of juglone (5-hydroxyl-1 4-naphthoquinone) in xylem sap exudates of walnut blocks callus formation at the graft union. Contrarily, Rongting and Pinghai (8,9) reported that there was a only trace amount of juglone in xylem exudate and that negative effects of xylem exudate on callus formation was not due to juglone. They stated that xylem sap exudation caus-

[1]University of Yuzuncu Yil, Faculty of Agriculture, Department of Horticulture, 65080, Van, Turkey, e-mail: kenyildiz@hotmail.com