Drought as a Cause of Oak Decline and Death on the South Carolina Coast

F. H. TAINTER, T. M. WILLIAMS, and J. B. CODY, Associate Professors, Department of Forestry, Clemson University, Clemson, SC 29631

ABSTRACT

Tainter, F. H., Williams, T. M., and Cody, J. B. 1983. Drought as a cause of oak decline and death on the South Carolina coast. Plant Disease 67:195-197.

Extensive oak decline and death along the South Carolina coast in 1981 was apparently aggravated by two severe summer droughts, the first in 1978, which resulted in only scattered incidences of decline and death, and another in 1980, which caused eventual rapid decline and death of thousands of urban and forest trees in spring of 1981. A lowered soil water table is blamed as the cause of injury to the shallow-rooted red oak species most affected. These included willow oak (*Quercus phellos*), laurel oak (*Q. laurifolia*), water oak (*Q. nigra*), and southern red oak (*Q. falcata*). *Hypoxylon atropunctatum* was an evident early colonizer of both the declined and the dead trees.

Decline and eventual death of oaks occurs periodically and causes a significant growth impact on forest trees and losses of shade and landscape trees. Such incidences have been documented in areas within Pennsylvania (2,5), West Virginia (3,9), Virginia (7,10), Florida, Mississippi, and Arkansas (4).

Defoliation (1,11) and drought (4,10) are two stresses that have been implicated with the onset of decline and death. Secondary invading organisms such as *Armillariella mellea* (1,3) and *Hypoxylon* spp., *Ganoderma lucidum*, and *Agrilus bilineatus* (4) have contributed to tree death in some decline situations. The limiting climatic factors, such as low rainfall (6), that trigger the decline syndrome are not well understood.

In late 1980 and early 1981, a widespread and striking decline and death of red oaks occurred along the South Carolina coast from just north of Georgetown to Myrtle Beach. This manuscript describes our investigation of the causes of this decline and death.

MATERIALS AND METHODS

South Carolina experienced a severe drought during 1980. Assuming that moisture stress is a major contributing factor to oak death, it was not surprising that there was an increase in dead oak trees the following year. Following inquiries from extension personnel concerning the increased incidence of dying oaks in Georgetown County in fall of 1980 and early spring of 1981, a roadside survey was conducted during May 1981 to determine the extent of decline and death and the tree species involved. The survey covered a peninsula of land about 4.5–8 km wide (bounded on the west by the Waccamaw River and on the east by the Atlantic Ocean) and about 56 km long (from the Belle W. Baruch Experimental Forest on the southern tip to Myrtle Beach in the north). The entire upland portion of the peninsula is composed of the Lynn Haven-Leon-Rutledge soil association (8), which is typified by wet sandy soils of broad ridges. The Chipley series is a minor soil association also found and differs primarily in that it is underlain with sandy and loamy sediments rather than only sandy deposits. The survey was conducted along both sides of State Highway 17, which transects the length of the peninsula. Areas with a high incidence of decline and death in 1981 were reexamined in May 1982.

Precipitation data obtained from the Georgetown climate station located on the Baruch Forest were used to detail the extent of the drought. Water table data that were selected for incorporation into this manuscript were part of a survey of water table elevations initiated in 1975 in the 6,880-ha Baruch Experimental Forest. Forty-five wells were located throughout the forest on a 1,220-m interval grid. The elevation of each well top had been determined by profile leveling from a benchmark of known elevation.

Although that study is not yet complete, data from two wells were selected for more detailed examination. The forest and soil types at these two well locations were similar to the forest and soil types on the rest of the peninsula. Well No. 16, located in a laurel oak site on a Chipley soil series, has a land-surface elevation of 4 m above sea level and a relatively deep water table level of 1.5–3 m below the soil surface. The soil texture is sand or fine sand to depths of 2 m or more. Well No. 29 is in a water oak site on a Lynn Haven soil series and has a relatively shallow water table, only 50–60 cm deep. Soil texture is fine sand.

RESULTS AND DISCUSSION

Oak mortality was generally widely distributed on the peninsula of land between the Waccamaw River and the Atlantic Ocean, from just north of

Fig. 1. Laurel oak shade tree that died in spring 1981 at Pawleys Island.

Fig. 2. Stroma (arrows) and perithecia of *Hypoxylon atropunctatum* on laurel oak tree killed by drought.

Accepted for publication 13 July 1982.

0191-2917/83/02019503/$03.00/0

Georgetown to Myrtle Beach, and was most severe along State Highway 17 in the vicinity of Pawleys Island and Murrells Inlet. Red oaks (subgenus *Erythrobalanus*) were the major group of trees affected, with extensive mortality in willow oak (*Quercus phellos* L.), laurel oak (*Q. laurifolia* Michx.), water oak (*Q. nigra* L.), and southern red oak (*Q. falcata* Michx.).

Many large, valuable ornamental oaks had been killed, especially in the vicinity of Pawleys Island (Fig. 1). Equally striking were the patches of forest trees, often exceeding several acres, that had been killed. This type of death was most evident near Murrells Inlet. The aesthetic losses were particularly important because the area is a popular tourist attraction.

Almost all dead trees and many declined trees had fruiting bodies of *Hypoxylon atropunctatum* (Fig. 2) growing on them when examined on 13 May 1981. On dead trees, gray-to-brown stromata of this fungus were evident under the sloughing bark on main stems and most major branches. Where patches of trees had died, virtually every oak stem had stromata of *H. atropunctatum*. On declining but still living trees, stromata of *H. atropunctatum* were also prevalent. Bark usually remained intact on a narrow band of living sapwood from the soil line up the trunk and into the still-living branches. Discussions with residents indicated that, once the stromata were visible, the trees did not survive more than a few weeks. At one restaurant we visited, the owner had removed all of the dead trees from his grounds earlier in 1981, leaving declined but still living trees in hope that they would survive. Several months later he had to remove these trees as well because they died after partially leafing out.

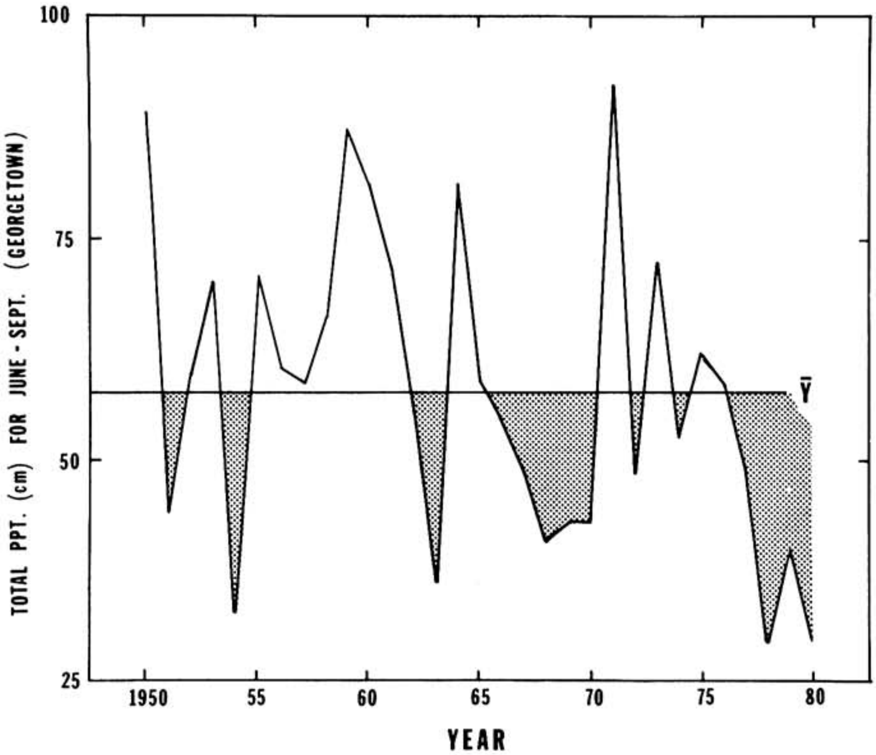

Fig. 3. Total summer precipitation (June–September) for period from 1950 through 1980 at the Georgetown, SC, climate station.

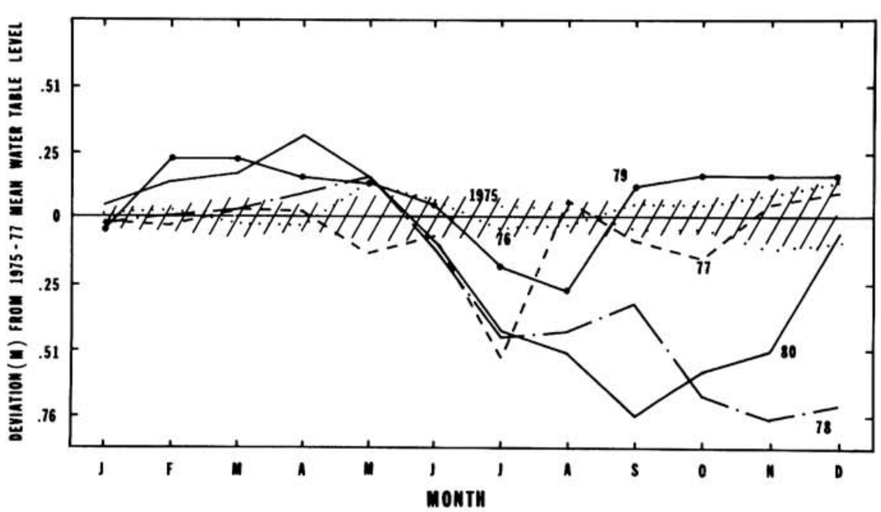

Fig. 4. Monthly deviation in the 1978–1980 water table level from the 1975–1977 mean (shaded area indicates the 95% confidence interval) at well No. 29.

The 30-yr record of total summer precipitation (June–September) for the Georgetown climate station is shown in Figure 3. Well below normal summer precipitation was recorded in 1954, 1963, 1978, and 1980. Somewhat wetter but still below normal rainfall occurred in 1951, 1966–1970, and 1979. Precipitation for 1978–1980 was lower than for any other period during the past 30 yr.

The drought is reflected by water table changes in the two chosen wells. The level in well No. 29, located in a water oak site on a normally shallow water table, showed substantial depletion from the mean depth in 1975–1977 when precipitation was close to normal (Fig. 4). Figured on a seasonal basis, the precipitation in 1975–1977 was within 5% of the 30-yr average. The deeper water table at well No. 16 (the laurel oak site) had a similar pattern with a larger range.

The continuous record from well No. 16 also showed more dramatically the difference between the 1978 and 1980 droughts. In both years, the water table dropped 2.5 m below the surface and remained near that level for nearly 2 mo. In 1980, evapotranspiration exceeded rainfall from mid-March through early October, whereas in 1978 evapotranspiration did not exceed rainfall until early May.

A few scattered cases of death were reported in the fall of 1978 in the area south of Georgetown and near Charleston on other soil types. In the area surveyed, increased incidences of mortality were reported by late summer of 1980, but most trees died shortly after leafing out in the spring of 1981. In a sense, the symptoms one normally associates with decline, such as fewer or smaller leaves, were present only for a few weeks after leaf flush, gradating quickly into death.

The prolonged drought of 1980 resulted in a significant drop in the water table. The affected trees, which developed shallow root systems and wide-spreading growth form, were unable to obtain sufficient water in 1980, and many died. It is possible that the 1978 drought had caused some root mortality that was then compounded by the 1980 drought. Since all three years from 1978 to 1980 had lower than normal summer rainfall, the yearly effects may have been synergistic. The well level readings reported here should be regarded as only an approximation of the moisture stress that the dead trees had been exposed to because no decline or death were evident at the well locations. It is therefore likely that water table levels were even lower where decline and death were abundant.

The variable pattern of decline was probably due to rainfall distribution. In periods like 1980, frontal and tropical rainfall is greatly reduced. The primary sources of rain during these times are sea breeze-induced thunderstorms. When the sea breeze moves inland, it interacts with normally eastward-moving environmental air to produce thundershowers along the inland sea breeze edge. These showers move northward, parallel to the coast, until early evening when the sea breeze subsides and they move inland. Only a chance process determines which locations will receive rain during this time. The areas of greatest decline detailed in this report may be those areas that received the fewest of these random showers.

A follow-up survey on 19 May 1982 showed little long-term evidence of the extensive decline and death of the preceding year. Dead ornamental oaks had been removed and the patches of dead forest trees had been utilized by firewood gatherers. The only remaining visual evidence of drought effects was a somewhat higher than normal incidence of stag-topped oak trees. No *H. atropunctatum* was evident on these trees.

LITERATURE CITED

1. Dunbar, D. M., and Stephens, G. R. 1975. Association of twolined chestnut borer and shoestring fungus with mortality of defoliated oak in Connecticut. For. Sci. 21:169-174.
2. Fergus, C. L., and Ibberson, J. E. 1956. An unexplained extensive dying of oak in Pennsylvania. Plant Dis. Rep. 40:748-749.
3. Gillespie, W. H. 1956. Recent extensive mortality of scarlet oak in West Virginia. Plant Dis. Rep. 40:1121-1123.
4. Lewis, R., Jr. 1981. *Hypoxylon* spp., *Ganoderma lucidum*, and *Agrilus bilineatus* in association with drought related oak mortality in the South. (Abstr.) Phytopathology 71:890.
5. Nichols, J. O. 1968. Oak mortality in Pennsylvania: A ten-year study. J. For. 66:681-694.
6. Schoeneweiss, D. F. 1978. Water stress as a predisposing factor in plant disease. Pages 61-99 in: Water Deficits and Plant Growth. Vol. 5. T. T. Kozlowski, ed. Academic Press, New York. 323 pp.
7. Skelly, J. M. 1974. Growth loss of scarlet oak due to oak decline in Virginia. Plant Dis. Rep. 58:396-399.
8. Smith, B. R., and Hallbick, D. C. 1979. General soil map—South Carolina. Soil Map 48. S. C. Agric. Exp. Stn., Clemson University, Clemson.
9. Staley, J. M. 1965. Decline and mortality of red and scarlet oaks. For. Sci. 11:2-17.
10. Tryon, E. H., and True, R. P. 1958. Recent reductions in annual radial increments in dying scarlet oaks related to rainfall deficiencies. For. Sci. 4:219-230.
11. Wargo, P. M. 1977. *Armillariella mellea* and *Agrilus bilineatus* and mortality of defoliated oak trees. For. Sci. 23:485-492.