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Lightning Strike Simulation for Studying Southern Pine Bark and Engraver Beetle Attacks

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SUMMARY

Endemic populations of the southern pine beetle (*Dendroctonus frontalis* Zimm.) and *Ips spp.* attacked loblolly pines (*Pinus taeda* L.) on which lightning strikes were simulated with detonating cord in the field. Southern pine beetles were reared in successive generations in these trees from fall 1981 through spring 1982; only *Ips spp.* attacked treated trees through December 1982. Lightning strike simulation provides an alternative means of studying bark beetle attack and opens the way for comparisons with natural lightning strikes.

Keywords: Lightning strike simulation, southern pine beetle, *Ips, Dendroctonus frontalis.*

INTRODUCTION

Lightning strikes have a significant effect on bark beetle ecology (Komarek 1964; Schmitz and Taylor 1969; Clarke 1970; Taylor 1969, 1974) including that of the southern pine beetle (SPB) (*Dendroctonus frontalis* Zimm.) (Thatcher and Pickard 1964). Lorio and Bennett (1974) reported that for a 4-year period an average of 29 percent of active SPB spots were initiated in lightning struck trees; in any one month lightning accounted for none to as many as 77 percent of the infestations. In some cases external lightning damage is not visible (Komarek 1964, 1968; Ducharme 1974), but physiological change could make the tree suitable for beetle attack. Therefore, the number of spots (=infestations) attributed to attack by SPB on lightning struck trees (Hodges and Pickard 1971, Lorio and Bennett 1974) is probably conservative; actual values could be considerably higher.

Lightning struck trees may attract SPB with a release of volatile oleoresin fractions from the shower of finely divided bark and needle particles (Taylor 1973, Lorio and Yandle 1978); struck trees offer a favorable attack and brood development site for SPB and *Ips spp.* as a result of reduced oleoresin exudation pressure, reduced oleoresin flow, reduced relative water content and increased reducing-sugar content of inner bark (Hodges and Pickard 1971). Anderson and Anderson (1968) associated successful attack by three *Ips* species on a lightning struck loblolly pine with reduced oleoresin exudation rate.

Taylor (1973) simulated lightning strikes with explosive detonating cord (primer cord) in a study to evaluate lightning as an ignition source for forest fires, and Safranyik and Whitney (1980) used detonating cord to destroy mountain pine beetle (*Dendroctonus ponderosae* Hopkins) brood in lodgepole pine. In the present study a lightning strike simulation (LSS) technique applied to loblolly pine (*Pinus taeda* L.) is described that results in southern pine bark beetle attack.

METHODS

On the England Air Force Base Ordnance Disposal Range near Alexandria, LA, sections of 50 grain per foot PETN (pentaerythritol tetranitrate) detonating cord were placed in various patterns and

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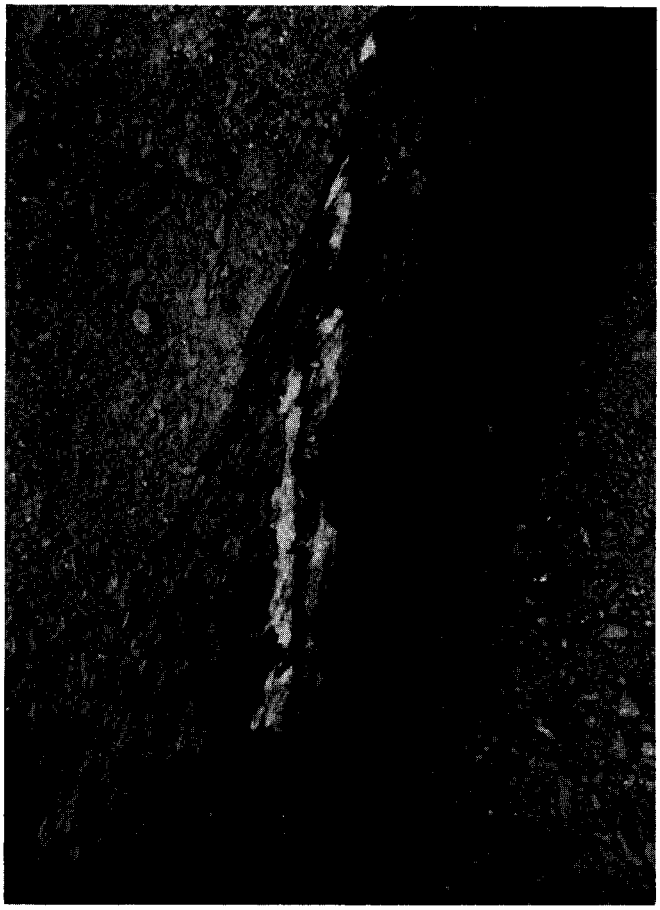

Figure 1.—*Results of lightning strike simulation with single strand 50 grain/foot PETN detonating cord on 12" diameter loblolly pine bolt.*

Figure 2.—*Lightning strike simulation with 50 grain/foot PETN detonating cord spiralled 1½ times around 10.5 inch dbh loblolly pine, Catahoula Ranger District, Kisatchie National Forest, Mar. 25, 1982. Detonation courtesy Explosive Ordnance Disposal, United States Air Force, England Air Force Base, Louisiana. Exposure: 1/125 sec,fll, Kodacolor 400 film.*

shaped charges on 6-foot loblolly bole sections to determine the best technique to simulate a lightning strike effect. A single strand of detonating cord spiralled tightly around a bolt, maximizing contact with the bark surface, produced the best effect (fig. 1). The bark was split and the bark and phloem separated from the wood up to 2 inches on either side of the detonating cord.

Lightning strike simulation was carried out on the Catahoula Ranger District, Kisatchie National Forest in central Louisiana. Five loblolly pines were tested in 1981, two in mid-September and three in mid-October. The dbh range was from 10 to 19 inches. In 1982, 32 trees were treated from March through December at three to five week intervals; all were 10 to 12 inches in dbh.

A single strand of detonating cord was spiralled 1½ times around each of the trees from 30 feet to 3 feet on the bole, where the cord was brought parallel to the ground to a small sapling for attachment of the electric blasting caps. Preparation for blasting, placing of the detonating cord, and detonation (fig. 2) were provided by the Explosive Ordnance Disposal Team, 26th Combat Support Group, U.S. Air Force, England Air Force Base.

OBSERVATIONS

Observations were made of each tree twice a week for 30 days in the 12-15 foot areas of the tree bole for evidence of SPB attack. Within 7 to 10 days after LSS, black turpentine beetles (BTB) (*Dendroctonus terebrans* Oliver) attacked at the base of the tree, followed by *Ips calligraphus* (Ger-

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mar) at 20 feet. Southern pine beetle appeared to be the third insect species to attack the LSS pines, but after 5 days predominated on the bole from 3 to 25 feet.

Southern pine beetles attacked both trees treated in September 1981. The first confirmed attack occurred 11 days after treatment. Within 10 days SPB attack shifted to the second tree. Adult SPB brood emerged from the first tree 2.3 months later. The onset of cold weather delayed brood development in the second tree, and egg though adult development took 3.9 months.

The three trees treated in mid October 1981 "pitched out" a few SPB attacking during the first 10 days, but two of these trees were later successfully attacked. Development of SPB took 3.8 months; emergence was in early March 1982.

In 1982 two of the three late March LSS trees were not attacked by any beetles except BTB until May when *I. calligraphus* became the dominant beetle in both trees. However, careful inspection of these trees revealed that a small number of SPB attack sites and SPB galleries were present (table 1). Three of the 14 loblolly pines, one in March and two in May, were arbitrarily treated with the SPB aggregating pheromone frontalure for 24 hours following LSS. They were attacked by SPB within 24 hours. Trees not subject to LSS that were close to frontalure treated LSS trees were also attacked and killed by SPB.

Four of the five 1981 LSS trees were successfully attacked by SPB even though no aggregating pheromone was used. All three LSS trees on which aggregating pheromone was used were successfully attacked by SPB, as were five nearby untreated trees (table 1). From June through December 1982 none of the 26 trees upon which LSS was conducted were attacked by SPB; all were attacked by *I. calligraphus* (Germar).

DISCUSSION AND CONCLUSIONS

In past attempts to induce attack, even with the use of frontalure, loblolly pines were able to pitch out SPB. With LSS trees, pitch tubes were few and inconspicuous, and it may be that fewer beetles are required for a successful attack than on similar uninjured trees. Observations of the few pitch-outs of SPB and absence of pitch tubes on LSS trees agree with those of Hodges and Pickard (1971) and Taylor (1969). The LSS technique offers the opportunity to compare natural lightning strikes and LSS for the study of physiological conditions, oleoresin release and quality, and attraction to bark beetles.

Those LSS trees not attacked by SPB were attacked by *I. calligraphus*. This may have been because endemic SPB populations are not uniformly

Table 1.—*Lightning strike simulation on loblolly pines Sep. 1981–May 1982, Catahoula Ranger District, Kisatchie National Forest, La.*

Treatment date	LSS[1]		Attacked by: SPB[2]		*Ips*	
	Treated[3]	Not treated	Treated	Not treated	Treated	Not treated
1981						
14 Sep.	....	2	....	2	....	0
14 Oct.	....	3	....	2	....	0
1982						
25 Mar.	1	2	1(+1)[4]	0	0	2[5]
11 May	2	2	2(+4)[4]	0	0	2
19 May	....	2	....	1	....	0
24 June–16 Dec.	....	26	....	....	....	26
Totals	3	37	3(+5)[4]	5	0	30

[1]Lightning strike simulation.
[2]Southern pine beetle (*Dendroctonus frontalis* Zimm.).
[3]SPB aggregating pheromone, frontalure.
[4]Numeral in parentheses indicates trees close to a LSS-frontalure treated tree.
[5]Includes a few SPB galleries.

distributed across the forest or because the response of each beetle species to LSS trees may vary with season, host-tree, or site/stand conditions. All trees showed the same sequence of attack after LSS of BTB, *I. calligraphus,* and then SPB.

Anderson and Anderson (1968) observed that successful *Ips* attack was associated with low oleoresin exudation rate. *Ips grandicollis* and *I. calligraphus* attacked first at the base of the crown with mass attack by *I. calligraphus* occurring five weeks after the strike. The size of their subject tree, the time of year, geographic variation, the type and extent of the damage, and the endemic beetle species available for attack could easily account for differences in time and nature of attack.

All of the trees subjected to LSS were attacked by southern pine bark or engraver beetles. Our observations with frontalure indicate it may be used as an adjunct in the study of SPB attack patterns or responses to LSS.

It was originally thought that LSS would serve as a means by which attack by SPB could be generated in the field if a SPB population was present. Following the completion of the 1981 through May 1982 LSS studies a SPB spot that could have been the source for the attacking SPB was found within 300 yards of the LSS sight. More extensive studies of this technique and its application are needed to determine its full relationship to bark beetle attack.

The trees used for LSS were in stands that are considered to have low risk of SPB attack by the evaluation of resource data site/stand characteristics (Lorio and Sommers 1981). Since some trees were attacked more than 10 days following LSS, suitability or attractiveness of the blasted host tree may not result from the immediate bark, needle, or resin particle shower mentioned by Taylor (1969, 1973) or Lorio and Yandle (1978). The frequency and intensity of beetle attack may be complicated by the effect of temperature on the release of chemicals from the tree, the oxidation rate of wound exudate, or the level of endemic beetle activity.

Lightning strikes may serve as a reservoir of populations during endemic periods especially in low risk stands. A study of LSS in high risk stands would add to our knowledge of population dynamics of these destructive insects.

Lightning strike simulation is a tool that allows the researcher to induce attack by bark beetles. Researchers considering the use of this technique should seek the services of a properly trained and certified blaster for the purchase, storage, transportation, application, and detonation of detonating cord and blasting caps.

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