LIGHTNING AND TREES

by Ernest W. DeRosa

The exact cause of lightning still remains uncertain. Thunderclouds seem to be charged with positive electricity at the top and negative electricity at the bottom. At the very base of the cloud there is often another smaller region of positive charge.

The source of these charges is understood to be largely due to precipitation and air currents. As water falls to the ground it separates into smaller and smaller rain drops. As these drops of water break apart, a separation of electricity takes place. The water receives a positive charge and the air currents a corresponding negative charge. There frequently exists great differences in the electrical potential between the earth and air during thunderstorms, and the electrical conditions of the atmosphere and earth may change instantly from negative to positive. On the ground below, a moving carpet of positive electric charge is induced which follows beneath the drifting cloud. Over high points like hilltops, buildings, or trees the effects of these charges are greatly intensified.

Two forms of lightning are generally recognized — 'forked lightning' which passes between the cloud and the ground, and 'sheet lightning' which occurs completely within the cloud. We shall focus on 'forked lightning' since these discharges affect us on earth, and affect trees.

A lightning discharge to the ground is initiated by enormous differences of electrical potential between earth and cloud — as much as 100 million volts! Each lightning stroke to the ground begins in the cloud as a local discharge between the negatively charged region and the small positive charge near its base. This frees electrons and forms a conductive channel along which they travel towards the ground in a succession of steps, often referred to as a 'stepped leader'. These steps give lightning it zig-zag appearance. The negative charge from the cloud moves continuously towards the ground, rapidly extending an electrically conductive path through the nonconductive air along which the return stroke can flow. This is a discharge which leaps upwards from the earth, usually from a high point, for the stepped leader rapidly enhances the positive charge on the surface as it approaches the ground. When the two discharges meet, a conducting channel to earth is established, which lights brilliantly as the result of the return stroke. This is what we see as lightning as it moves upwards at 1/10 to ½ the speed of light. This is so fast that the entire channel appears to light up at once, not showing the relatively weak light from the stepped leader.

Thunder results from the passage of a return stroke, for the enormous surge of current through a channel produces great heat. This increases the air pressure in the channel so that it expands with supersonic speed, producing a shock wave which we hear as thunder.

Trees likely to be struck. Lightning prefers to strike tall, pointed objects, and will often strike the same place more than once. When the discharge occurs, the bolt will tend to follow the shortest, most conductable path to the earth's surface. Therefore objects that stick out above everything else are more likely to be struck. This is why a person in a boat on flat water, or a person standing in an open flat field is in danger of being hit by lightning.

The tallest trees in a grove, trees in open areas, trees on the edge of a grove facing an approaching storm, trees on hilltops, and trees located close to buildings where wiring or plumbing might enhance ground conductivity are likely points of discharge for lightning bolts. Often they do become ground terminals of lightning discharges. Unfortunately it is these old, large, historical trees that we value most in our communities.

Species of trees most commonly struck by lightning include oak, elm, maple, poplar, ash, spruce, fir, pine, and tuliptree. On the other hand, beech, birch, and horsechestnut seem to be rarely struck by lightning. During thundershowers, trees become more or less drenched with rain. The more thoroughly wet the tree is the less susceptible it becomes to lightning strokes because of its better electricty-conducting surface (Stahl, 1912). Therefore smooth-bark trees such as beech appear to be more immune to lightning because they become thoroughly wet during storms, while oak and other rough-bark trees do not.

Damage to trees. Lightning effects on trees vary from no noticeable damage to total destruction. In many cases minimal damage may be evident on the trunk (cracking, peeling of bark, etc.), while the roots have suffered considerable damage. Often the ground around a tree hit by lightning will show cracks that follow the roots of that tree. Small plants near the base of the trunk may be killed. Leaves may wilt immmediately and die due to heat from the lightning bolt. Other times branches may be cut off, trunks may split down the middle, or the entire tree may explode or burn. Lightning damage to trees depends on a variety of factors. The physiology of the tree seems to have a direct influence on the lightning affects. Lightning often takes a spiral course, following the grain of the wood, which is sometimes very irregular (Stone, 1916). In some cases the lightning discharge follows the line of least resistance — the cambium zone, burning a small channel down the trunk, which often results in the formation of a ridge on the bark. Trees with high internal resin contents make better conductors of electricity than those with lower resin contents. Therefore these high resin trees (pine, spruce, fir, etc.) may be more susceptible to internal heating and explosion.

The action of the lightning bolt itself has a direct influence on the resulting damage to trees. The amount of current or voltage will affect the amount of damage to the tree. Obviously the more voltage the bolt carries the hotter it is and the more destructive potential it has. The lightning discharge may disperse so as to cause no visible mechanical injury to the tree, but an area of the cambium may be killed resulting in girdling and eventual death of the tree.

The surrounding points near the tree may influence the direct action of the lightning bolt. The tree may suffer minimal damage because it was 'under the influence' of the lightning bolt but not directly hit. 'Under the influence' means within the electrical force field of the lightning bolt but not in direct contact with the bolt itself. This same phenomenon occurs when people stand under trees for shelter during storms. If the tree is struck by lightning the person underneath may sustain injury because they were within the electrical force field of that lightning bolt, since people are good conductors of electricity. Immediate action (Cardio Pulmonary Resuscitation — CPR) will often revive people in this situation. A person struck directly by lightning would not survive.

Treatment. Since damage to the root system may be much more extensive than the noticeable damage to trunk and branches, time (approximately 1 year) should be allowed for observations of the tree's response to the lightning strike before costly treatments are made which may be of no avail in the long run. The roots of trees struck by lightning should be examined for extent of injury. If more than 50% of the root system appears healthy then proper tree maintenance procedures should help that tree recover.

Trees injured by lightning should be treated like other stressed trees. Broken branches or stubs left by severed branches should be properly pruned. Loose bark should be removed and injured bark cut back to healthy tissue. Fertilizers low in nitrogen but high in phosphorus are suggested to improve the vigor of the injured tree. These are the types of fertilizers often used in vegetable gardens. Watering during dry conditions is of utmost importance in proper tree care to restore and maintain vigor.

Lightning protection. Lightning protection equipment is available to help preserve trees of historic or sentimental value, and to protect trees in situations where they are likely to be struck by lightning. The safety of nearby buildings, cars, and people from the damaging side effects of a lightning bolt striking a tree is also an important consideration.

Lightning protection for trees is similar to the lightning rods that protect buildings. A copper cable is placed as high as possible in the tree. Specially designed copper fasteners are used to fasten the cable all the way down the trunk to the ground. These fasteners allow for slack and continued growth of the tree. The end of the cable is attached to a ground rod driven deep into the soil out beyond the main root area. Trees with broad crowns may require additional conductors which extend into the highest parts of the side branches in order to cover the spread of the crown. Lightning protection systems should be checked periodically and adjusted to allow for growth and expansion of the tree.

"Lightning Protection Installation Systems Standard" is available from the National Arborists Association, 3537 Stratford Road, Wantagh, New York 11793.

Homeowners are warned not to attempt to install lightning protection systems in trees. One should consult a commercial arborist with the proper training and experience.

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ABSTRACTS

Johnson, W.T. 1982. **Horticultural spray oils for tree pest control.** Weeds, Trees & Turf 21(5): 36-40.

Oil is one of the oldest natural pesticides. In the first century A.D., the Roman scholar Pliny wrote that mineral oil would control certain plant pests. It was also known at that time that the oil was liable to injure plants. Between 1942 and 1970, teams of petroleum chemists and entomologists made great strides in spray oil science and technology. Arborists and nurserymen benefited from the work on fruit trees because many of the pests controlled by oil were the same pests that injured shade trees and shrubs. Today, superior horticultural oils are being produced by four oil companies. Modern spray oil can kill arthropods in two ways: 1) by penetrating the egg and interfering with the vital metabolic processes, or 2) by preventing respiration through egg shells or respiratory passes (tracheae) of both immature and mature insects.

Powell, C.D., Jr. 1982. **Developing a spray calendar.** Am. Nurseryman 155(10): 49-51.

Disease infestations and development occur in cycles that are based largely on the seasons. Diseases go through these cycles mainly because their hosts go through cycles of growth and development that are also governed by the seasons. In the landscape, there are not many diseases that require chemical control programs. However, we should remember that chemicals are only one means of combating plant diseases. We should be just as interested in using resistant varities, attempting cultural modifications, or choosing an alternate planting site. The amount of stress a plant is subjected to has a good deal to do with how widespread the disease will be on the plant at the end of any one season. Spray prevention of diseases should be thought of as a fourth means of defense against diseases. Using resistant varieties, thinking about cultural control, and practicing good sanitation and management should all be considered before resorting to chemical sprays.