SYMPTOMS AND CONDITIONS OF ENVIRONMENTAL TREE DISEASE

By Eugene P. Van Arsdel

Environmental diseases are those caused by the adverse effects of the environment on the tree.

The maladies fit my definition of diseases better when they are more or less continuous, but many authors include lightning as a non-infectious disease. The adverse environmental conditions can be physical or chemical and can affect the plant directly or through the soil, water, or air. Direct physical disturbances can be mechanical injuries to the above ground parts of the tree, but more commonly they are to the roots because people are not very much aware of the part of the tree that is underground. Physical changes in the level or drainage of the soil are often harmful. Harmful chemicals can be in the soil, the water, the air, or may be applied by people. Physical changes in the atmosphere such as adverse weather (e.g. early or late frost) or sudden changes in the microenvironment (e.g. changes in a nearby structure), or the introduction of chemicals (air pollution). Environmental maladies involve several species of plants more often than infectious or biological diseases do, and they often stop at the property ownership lines.

Eugene Van Arsdel is Associate Professor of Forest Pathology at Texas A & M University's College of Agriculture. Dr. Van Arsdel is a member of the Weeds Trees & Turf Advisory Board.

Sycamore seedling showing salt injured lower leaves caused by watering with high chloride content water. Newer leaves grew in rainy period and have no chloride symptoms.

Trees Affected

All trees can be affected by environmental maladies at some level of almost anything; e.g. live oaks are resistant to salt, but enough salt is frequently accumulated to poison them. Some species of trees are more susceptible to one environmental factor than another: American elms withstand excess water much better than many other trees (since most people water too often, this contributed to their success as a shade tree before the Dutch elm disease epidemic); however, in sub-humid regions (central Texas) where slightly saline irrigation water is common the elms usually die from the salt before oaks do. Evergreen trees are often more susceptible to air pollutants than deciduous trees, generally because the evergreen leaves stay on longer to be affected by the pollutants.

Occurrence

Environmental diseases can occur anywhere, but they are particularly prevalent in the urban environment where man has had the greatest influence. Frost and sunscald are widespread, other maladies are often confined to particular areas; e.g. there is almost always a great deal of sulfur dioxide pollution injury around a copper, lead or zinc smelter. Locations are important in the diagnosis of environmental diseases. The coastal areas have special problems with storms blowing sea water inland to injure trees with salt. The damage can cover large areas, but only within a few miles of the coast.

Damage

The damage ranges from hardly noticeable to widespread death of the trees. Salt in the irrigation water can cause a slight dwarfing of leaves that is hardly noticeable to all but the most careful observers, but certain smelters are famous for being surrounded by miles of dead trees and denuded land (Linzon 1968).

Symptoms

The symptoms showing that environmental injury is occurring are varied, but many can be detected from leaf symptoms. These have been presented in another paper (Van Arsdel 1978). Some specific symptoms of the particular groups of maladies are presented later. Some generalized symptoms are those of root smothering: the leaves turn yellowish with no definite lines between color changes. Nearly all of the leaves are involved and the injury is not restricted to either new leaves or old ones. These symptoms are characteristic of natural gas leaks, earth fill over the roots, flooding or interrupted drainage, or daily watering. Gas leaks probably involve several species of plants, and usually involve the grass too.

Control

The key to controlling environmental diseases is to determine the cause, then the cure often becomes evident. If a natural gas leak is the problem, much of the injury is permanent, but additional injury can be prevented by fixing the leak and aerating the soil (by pumping compressed air through, leaving the excavation hole open, etc.). To control air pollution, usually the source must be controlled. At times raising the stack height helps, but often that merely transfers the problem to another location. Other more specific controls will be discussed in the detailed sections of the paper handling the particular environmental disease.

Causes

The causes of environmental disease are many, and more are discovered each year, particularly as the human population increases, and the works of man encroach upon the natural environment more and more. A list of some of the more common ones are listed below.

Soil Disturbance — Construction Injury

Some builders and developers do many acts that often injure trees in the vicinity of their work. With their heavy equipment, such as bulldozers, the trees do not have much of a chance of surviving unless special care is taken to preserve the trees.

A partial list of these damages follow — roughly in the order of the amount of damage they do: (1) The worst is where they mean to kill the tree, and they push it over with a bulldozer and run heavy equipment over it. (2) Not quite as bad, but just as fatal is when they push the whole tree aside with the bulldozer along with a small island of attached dirt and leave the tree standing in a new location with only a small part of its roots to absorb water from the ground to supply the leaves with their required water. (3) They fill soil over the ground at the base of the tree which contains its roots. (4) They interrupt the drainage with a house, a wall, a sidewalk, or a mound of earth that makes the water back-up and suffocates the roots by flooding. (5) They cut the roots off when they excavate for foundation walls, service lines, sidewalks, streets, etc. (6) They crush the roots and break them up by running heavy equipment over the soil that contains them. (7) They wound and skin the bark on the stem by running tractors, trucks, etc. over them. (8) They drip oil from the crankcases and gear boxes onto the soil. This is both poisonous to the trees and prevents rainwater penetration. (9) They permit the ready-mix concrete trucks to dump concrete onto the soil, then they spread a thin layer of fill over it so you can not see where it is, (10) They run

Causes of environmental diseases:

1. Meteorological effects
   - A. Frost (low temperature)
   - B. Sunscald (high temperature)
   - C. Light
   - D. Drought
   - E. Lightning
   - F. Winter kill (warm wind with frozen ground)
2. Air pollution
   - A. Reducers
     - (1) Sulfur dioxide
   - B. Oxidizers
     - (1) Ozone
     - (2) Peroxy-acetyl-nitrate (PAN)
     - (3) Flourides
     - (4) Chlorides
   - C. Combinations (synergists)
     - (1) SO_2 and Ozone
   - D. Growth modifiers
     - (1) Ethylene
     - (2) 2,4-D, 2,4,5-T and other herbicides
   - E. Salts
     - (1) Blown seawater in natural salt storms
3. Water problems
   - A. Changes in amount or level
     - (1) Dams or other flooding (root smothering)
     - (2) Too frequent watering (sprinkler irrigation flooding — most common with automatic sprinkler systems) (root smothering)
     - (3) Complete change in watering cycle (stop watering for vacation trip)
   - B. Water pollution
     - (1) Salts in the irrigation water (common with many city water systems — often worst on house plants)
4. Soil modification
   - A. Mechanical (Bulldozer blight)
     - (1) Earth filling over the soil surface above the roots (root smothering)
     - (2) Cuts, ditches, sidewalks, and street grades (root cutting)
     - (3) Building foundation cuts (root cutting)
     - (4) Covering surface with asphalt, concrete or plastic (root smothering)
     - (5) Lowering water table by ditching
   - B. Chemical injuries (soil pollution)
     - (1) Salt injury
       - a. Irrigation water
       - b. Road salt
       - c. Oil wells (brine pools, etc.)
       - d. Mine tailings
       - e. Dog urine (male dogs on the corner shrubs)
     - (2) Excess fertilizer
     - (3) Illuminating or heating gas
       - a. coal gas (Ethylene)
       - b. natural gas (lack of oxygen = root smothering)
     - (4) Herbicide injury (Atrazine in grass fertilizer, or deliberate application — may be to driveway or fence)
5. Mechanical injuries to plant
   - A. Logging injuries
   - B. Lawnmower skinning
   - C. Rubbed spots, bumper skins, etc.
   - D. Broken branches
     - (1) Snow and ice breakage
     - (2) Bad pruning
     - (3) Truck breakage to branches.

the big trucks through the trees so they break up the branches, leaving exposed jagged branch stubs to serve as perfect entry courts for disease and decay fungi. (11) Lastly they cut the trees up for firewood and leave it there in a pile next to the base of a living tree. The fungus-bearing wood borers come out of the wood and enter the adjacent tree and transfer the local wilt fungus to the tree.

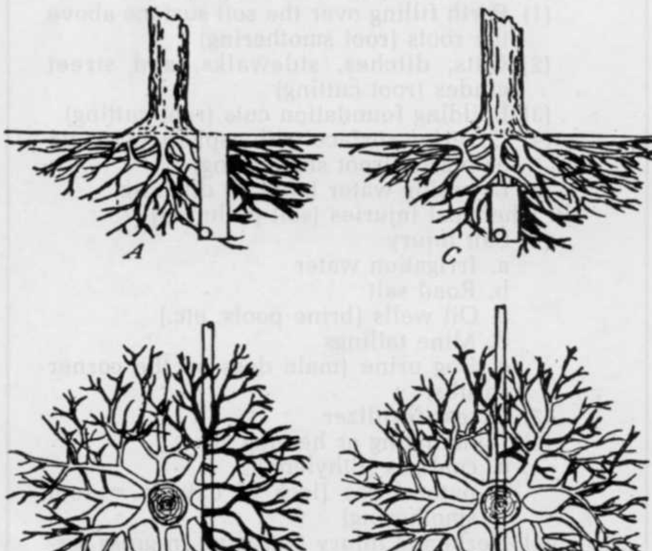
Symptoms

The symptoms of construction injuries often do not show until after the damage has been done, and often not until it is too late to save the trees. The symptoms of root suffocation (earth fill over the roots and dams raising the water level) are that the leaves turn yellow, with a general discoloration, the transitions from discolored to green parts are gradual.

Elms will die from saline irrigation before oaks will. Evergreens are often more susceptible to pollutants.

Control

The control of some of the construction injuries is possible after the damage has been done. It is expensive and difficult, and involves the excavation around the trees, the sterilization of the bark (some use alcohol, I have used 10% bleach), and the recreation of proper drainage by the installation of the drain tiles and French drains as shown in the following section on prevention. The drainage must be returned to the original soil level; this is usually easy to detect by the organic matter layer (or dark soil layer) at the original soil line. These construction injuries are much easier to prevent than to cure, so the major emphasis is placed on the prevention.



Root severing from trenching near tree. Fewer roots are severed by trenching directly to the trunk of the tree (D) and tunneling under the base (C) then trenching alongside (A,B). Severed roots are shown as black.

Reducing damage to trees during construction

A. Maintenance of the original soil surface and drainage level is the most important part of preserving the living tree.

1. Maintain the original soil surface if possible. The duff is full of fine roots. Removing the duff layer removes the fine roots and removes important sources of nutrients and important structural features.

2. Maintain the original drainage level. The roots are in one or two narrow strata (one in the surface-duff, the other just above the normal water table) any change in drainage either smothers the roots by inundation, or leaves them high and dry without moisture.

3. Where the grade must be lowered for a street, maintain the surface around the tree and build a retaining wall.

4. When filling, use drain tiles or French drains (covered ditches partially filled with coarse gravel) to maintain the original drainage level.

5. Avoid creating dams. House foundation footings are the most common dams. Trees die on the uphill side of the house, or in the courtyard.

B. Protect trees during construction.

1. Protect against skinning, barking, bumping, and the like.

2. Protect against soil compaction by tractors, trucks, etc.

3. Protect against root smothering from earth fill over the roots. Planks or slabs fastened to the tree do not protect the roots.

C. Keep root cutting to minimum. Keep the trenches beyond the crown drip-line, or tunnel under the tree. The figure on this page illustrates how cutting beside a tree cuts more roots off than going directly under it.

D. When fill around the tree is necessary, maintain the bark free from soil contact by constructing a mortarless wall around a well.

Do not fill to reduce brush killing for sod establishment. Sod only where necessary construction fill demands. To preserve the soil level and the trees, mow the brush and insert grass cuttings without fill. Keep the brush mowed until grass crowds out the woody plants and weeds.

E. Maintain original drainage line at the old soil surface by drain tiles, French drains or both.

F. Trees must be watered at the original soil line where there is fill. Therefore the bell tile openings should be lower than the surface to allow rain-

water to flow in. Well water and public water supplies usually have enough salt to cause injury when the amount of rainwater is reduced for prolonged periods. Tile tops should be protected from debris.
G. A superior type of well for preserving the tree roots through earth fill is the open dry well.
H. After the construction and change in grade, prune the leafy crown to reduce the leaf area by the same amount that the root area has been reduced. Assume a fifty percent reduction as the usual minimum. Prune by cutting out twigs. Cut every other twig to reduce the crown 50 percent.

Excess Watering and Saline Irrigation

Excess water can damage trees in three ways: (1) Daily watering smothers the roots by keeping them wet and sealing the soil surface which prevents the oxygen in the air from getting to the roots. (2) Slightly saline irrigation water that is satisfactory for irrigating lawn grass and many annual crops causes a buildup of salt in the leaves of perennials until toxic levels (more than 3000 ppm chloride) are reached. The salt is left behind in the leaves similar to the residue left behind in distilation. (3) The third type of excess watering problem is a longer term result that becomes evident after a few years. Water with high sodium content leaves residues of sodium in the soil. The plants take up the chloride, but the sodium is left behind. The pH of the soil goes up to more than 8.3 as the sodium accumulates. The condition that develops is called "black alkali", the structure of the soil collapses and the trees die.

Most chemistry laboratories can test the leaves for chloride and the soils for pH and sodium content. The soil can be tested for chloride as well, but we have not found the chlorides accumulating in the soil. The irrigating water can be checked in laboratory tests as well, but there are probably published data on the salt contents of the water.

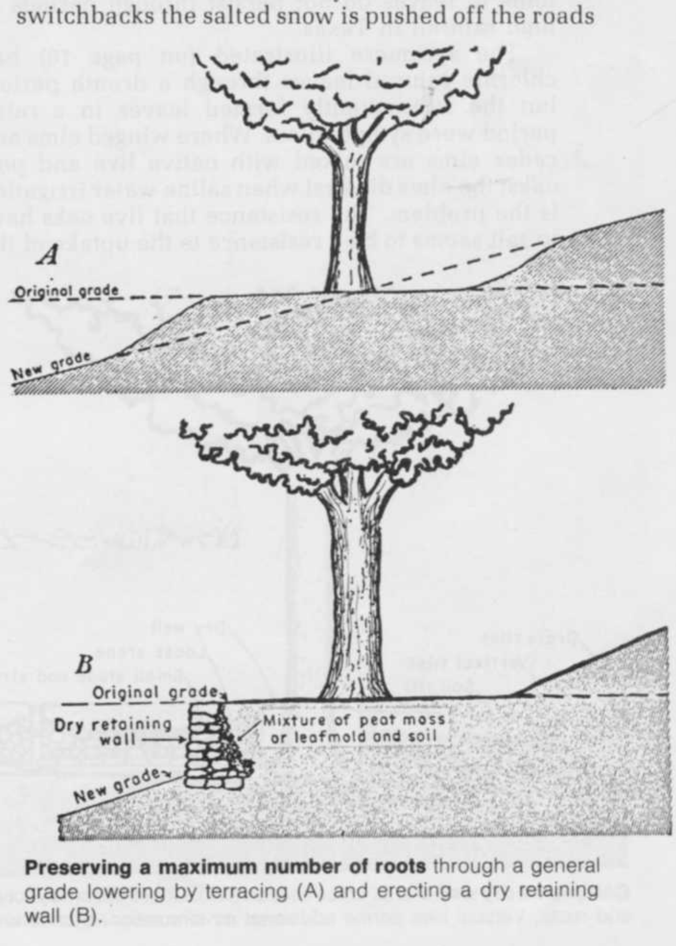
To determine what salts are present in the irrigating water, check the state reports of water quality. In Texas the Department of Health, Division of Water Hygiene has the salt contents of all public water supplies and publishes these analyses in a book (Texas Board of Health 1977). For information on salt in private water supplies, The Texas Department of Water Resources has books on water quality for most counties (Texas Department of Water Resources 1977). The salt contents of waters in most aquifers and many individual wells are listed.

The level of salt content in the irrigation water which is sufficient to start injuring the perennial vegetation is dependent upon the evaporation rate, the amount of rainfall, how long the plants have gone without rain, and the habits of the homeowner who is doing the watering. All of the public water supplies with their dissolved ion counts presented in the following table have been associated with salt injury and high salt contents in the leaves. On the basis of this information, it would seem that outdoor watering in a subhumid region with water containing more than 45 ppm chloride is likely to produce toxicity problems in trees. House plants, greenhouse plants, and other plants in containers under roofs where rain cannot fall usually have salt problems unless they are watered with rain water or condensation water from air conditioner coils.

In the northern parts of the United States and in the mountains where snow is common, salt is often spread on the roads to melt the snow and ice; this is concentrated by snowplows and in drainage-ways. The salt injury is common in parking lots where the salted snow is piled up around the ornamental trees and shrubs. On curvy mountain roads and switchbacks the salted snow is pushed off the roads

Table 1. Concentrations of selected ions in public water supplies.

County and City	Reaction	Calcium Ca	Magnesium Mg	Sodium Na	Sulfate SO_4	Chloride Cl	Total Dissolved Solids	Total Hardness
	pH	ppm	ppm	ppm	ppm	ppm	ppm	
BRAZOS CO.								
Bryan	8.4	2	<1	188	<4	48	670	34
College Station	8.5	2	1	317	<4	99	1100	10
TAMU M. Camp.	8.4	4	1	205	7	56	730	12
TAMU Annex	8.5	3	1	239	<4	63	840	12
TAMU Univ. Ac.	8.3	10	<1	456	220	329	144	26
DE WITT Cuero	8.8	10	2	255	42	152	860	31
KERR Kerrville	7.8	72	36	27	27	47	590	340
LIVE OAK Geo. West	8.1	54	14	319	227	272	1260	195
Three Rivers	7.2	274	1	121	356	249	1290	690
TRAVIS Austin	9.5	18	14	28	33	52	201	103
WICHITA Wichita Falls	7.7	43	7	72	27	137	404	137



Preserving a maximum number of roots through a general grade lowering by terracing (A) and erecting a dry retaining wall (B).

on the outside of the curves and tree injury or death is often found in such places.

Symptoms

The symptoms of root suffocation from too frequent watering are the same as those for earth fill and natural gas leaks. The leaves turn yellow, the discoloration is generalized, and there are no rapid gradations between the different colors seen on the leaves.

The symptoms from salt vary somewhat between plant species, but the peripheral scorch is quite characteristic. There is some variation between geographical regions. If saline irrigation water is applied after the leaves have reached full size in the spring where rainwater permitted full size growth, a grey or brown perimeter scorch with a definite edge on the discolored part develops.

This sharp edged peripheral burn usually has a dark line along the edge of the scorched area in Texas. Michigan chloride injury from snow melting salt has a similar distribution of scorched area on the leaf, but the color change is more gradual and there is more yellow between the brown and green areas. In Texas, leaves formed after the irrigation season starts are often dwarfed. No such dwarfing was seen in about 20 comparitive samples of Michigan leaves.

The high chloride content leaves were the same size as the symptomless check leaves which contained no measurable chloride. High chloride contents in leaves do not persist through periods of high rainfall in Texas.

The sycamore illustrated (on page 16) had chloride injured leaves through a drouth period, but the subsequently formed leaves in a rainy period were symptomless. Where winged elms and cedar elms are mixed with native live and post oaks, the elms die first when saline water irrigation is the problem. The resistance that live oaks have to salt seems to be a resistance to the uptake of the salt in the water by the roots of the tree. The elm leaves in a mixed stand always have much higher salt contents, but both elms and oaks start showing necrotic symptoms when the choride reaches 3,000 ppm in the leaves. Other species that are susceptible to salt and thus are good indicators of salt problems are sycamores, American elms, maples, ginkgo, sweet gum, and American holly. Yaupon, citrus, live oak, Chinese holly, Chinese tallow, and yuccas are among some of the more salt resistant trees.

Where there is a continuous source of saline water, such as by a leak in a water pipe, the leaves will often be dwarfed, even those that form in the spring. This can happen where the chloride levels in the leaves reach 1,000-2,000 ppm. Live oaks can develop thin crowns and dieback in addition to the dwarfed leaves where a continous source of saline water is available. Trees next to drainage-ways may get more salt than their neighbors.

Where there is an excess water problem on a lawn, the first symptom is often a yellowing of the leaves. This may indicate root suffocation, salt injury, or both. Next there are usually peripheral scorches present on the leaves from the salt. In cases where black alkali develops from excess sodium in the soil, in addition to the perimeter-scorch-chloride symptoms there will be dark brown discolorations. These dark brown discolorations have a sharply defined margin.

The damage and dieback of the trees takes a few years to develop. It usually starts in the center of the area to which the excess of water is being applied. The trees at the edge of the perched water pool live longer, since they have less root smothering and total water than those in the center. The effects of the alkali from the sodium build-up also seem to be worst in the center of the perched water pool. The alkali build-up is indicated by pH's above 8.3 in soil tests (The highest pH calcium can

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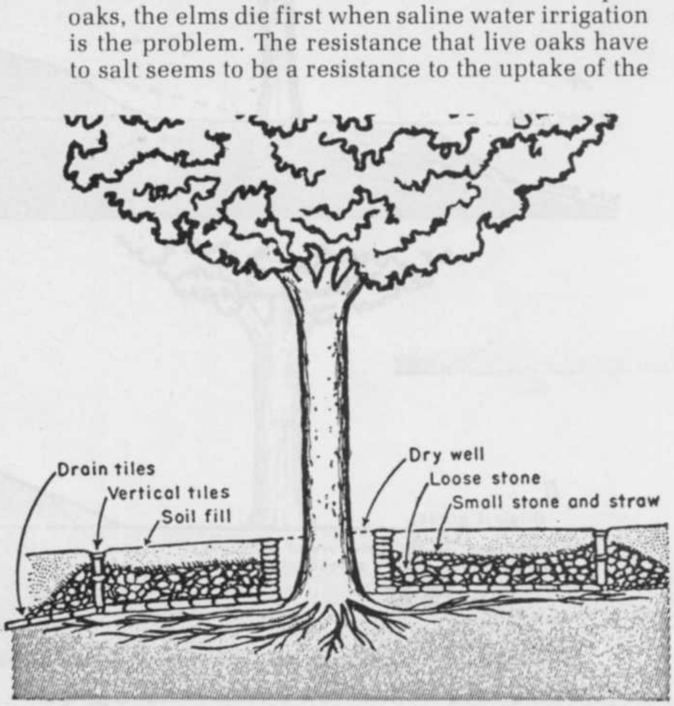

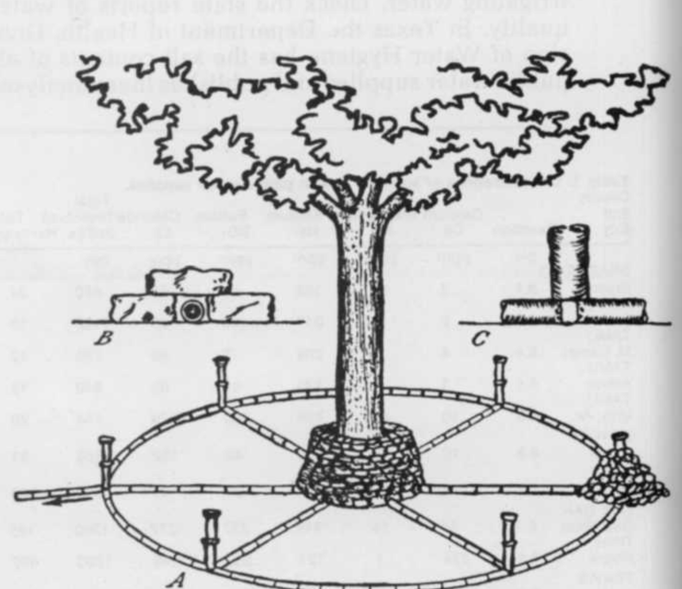

Completed dry well and fill cross section (left). Construction layout prior to filling (right). Tiles on ground are sloped away from trunk and roots. Vertical tiles permit additional air circulation. Stones around tiles provide support during fill placement.

make without excess sodium is 8.3). When the high pH is noted, tests for sodium are in order. The alkali pool is commonly referred to as "black alkali"; the soil structure collapses into a gummy mass which adds physical problems to the chemical toxicity of the soil (Longenecker and Lyerly 1974, Richards 1954, and Barber 1964). A forest soils text (Wilde 1946) says that soils with pH's 8.1-8.5 are toxic to trees and cause dwarfing, and that trees can not grow in soils with a pH above 8.5.

Control of watering injuries

To control root smothering and salt from the irrigation of lawns, water no more often than once a week (every 10 or 12 days is better). Water at each setting to equal about 2 inches of rain, until there is run-off; the run-off insures the flushing out of any salt that has built up on the surface from evaporation. Mulches on the soil surface (gravel, pine bark, composted leaves, etc.) help reduce evaporation from the soil surface and should reduce water use. The less water used, the less salt is left behind as the water evaporates from the soil surface or the leaves. Allowing the soil to dry between each watering prevents root suffocation. A neighbor of mine in Bryan only waters two or three times a year, and sometimes less often; his grass is usually brown, but his trees are the healthiest in the neighborhood.

In more arid climates where watering must be done because trees can not survive without artificial watering, gypsum ($CaSO_4$) can be added to the soil. The sulfate neutralizes the alkali from the sodium. Sulfur can also be added to get the same effect, but the amount of water soluble salts in the soil can continue to build up and eventually give you salinity problems. Watering once every three weeks should keep live oaks and post oaks healthy. All fertilizers (in areas where water is high in sodium) should be in the form of sulfates. Fertilizer salts also add to the total salinity; therefore, fertilizer use should be restricted.

Excess Fertilizer

Fertilizing grass lawns to a lush green with more than 1,000 pounds of fertilizer per-acre-per-year,

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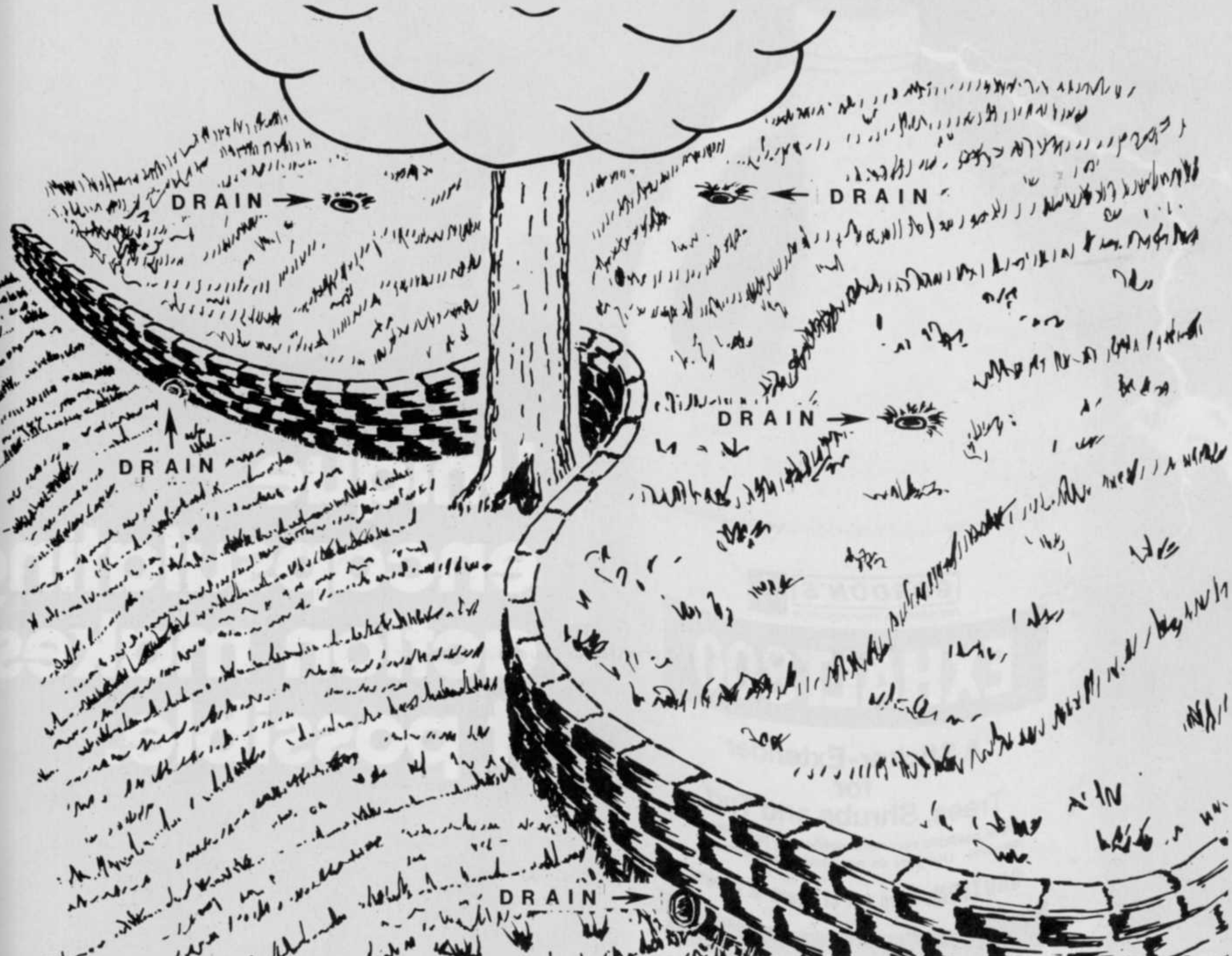

Open dry well at edge of filled slope provides air and water circulation to the area covered with fill. The wall should be a few inches higher than the fill to prevent debris from washing into the well.

on claypan or caliche soils in semi-arid areas where only small amounts can be leached away by rain, is often fatal to the trees. Because excess salts from fertilization are often accompanied by excess salts from irrigation water, these are difficult to separate. Where the grass is too green and too lush, even under the trees, it often indicates too much fertilizer (and/or salts) for the trees are being used. Often the grass is doing so well because the shallow tree roots have been killed.

Tests in several states (e.g. Ohio, Illinois) indicate that only nitrogen fertilizer helps trees (of the three principal nutrients). Phosphorus may help rooting on new transplants, and phosphorus may increase flowering. However, woody plants through their mycorrhizae can absorb phosphorus not available to crop plants, and its lack does not limit tree growth. Almost all Texas soils have an excess of potassium. It should not be added.

As a general rule, fertilizer applications should not exceed 435 lb./acre/year, or 10 lb./1,000 sq. ft./yr.

Deficiencies

In alkaline soils zinc and iron may be deficient in the trees even with an adequate supply in the soil. They may have to be added by foliar sprays to the trees. Foliage sprays of ½ percent solutions of iron and zinc sulphate can make the trees greener.

Trees in the Gulf coastal plains soils can increase growth and leaf retention by adding magnesium. Foliage sprays of ½ percent $MgSO_4$ turn yellowish trees green, but trees so treated showed remarkable increases in growth when serpentine gravel was spread around their bases when compared to trees without the serpentine ($Mg_3Si_2O_7 \cdot 2\ H_2O$);(in Bryan). Dolomite gravel should also be effective. These soils in Bryan do not show Mg deficiency in the soil tests, but the addition of magnesium gives improved color and improved growth in perennial woody plants.

Damaging Weather

Abnormal weather often harms vegetation. Through cultivation we extend the ranges of plants into regions where normal weather has adverse effects. This cultivation makes our plants more susceptible to weather.

Frost

Frost is usually associated with the passage of cold fronts in the continental United States. The cold front is the leading edge of a mass of cold air advancing into a warmer region. Most of these air masses are Polar, Continental air advancing into areas that average warmer. (In America we tend to consider frost a temporary condition, and a freeze the more permanent; in Europe, frost is used in the more permanent and colder sense we would call a freeze.) These temporary chillings occur in the summer in the Lake States, in winter in the Gulf coastal plain, and in the spring and fall in the intermediate latitudes.

These cold air intrusions cannot persist in the warmer heat balance, so the temperature is usually above freezing after a few nights.

Advected or transported frost is usually a part of the front passage, and is present the first or first and second nights of the front passage. Radiation frost occurs after the clouds of the front have passed, and additional heat loss to the sky (outward radiation) causes further cooling from the air mass temperature. Radiation frost usually occurs the second or third night after front passage. Microclimatic modifications are much more effective in mitigating radiation frost than they are advected frost.

Advected frost

In a forested region, nocturnal winds are much reduced by the roughness of the surface. The trees tend to protect against cold wind, and the heat stored in the tree bodies reradiates and tends to keep the trunk space (beneath the canopy) climate relatively warm. Therefore, the forest stand does protect against advected frost.

Radiation Frost

The trees are more effective as protectors against radiation frost (that frost produced by radiated heat loss on clear dry nights). In the northern hardwoods the temperature averages about 10°F warmer than in open field, but it may be as much as 15° warmer on a clear cold night.

In an oak stand in southern Wisconsin that I studied for three years, frost occurred 30-45 days later under the leaf canopy than it did in the open. In fact, it never frosted under the canopy until the trees were defoliated (Van Arsdel et al 1961).

Buildings are as good as trees at protecting against frost, heated buildings are better. Plants in courtyards or close to buildings receive protection from frost. The D:H ratios apply as well as they do in the forest.

Forest Openings

Forest trees greatly modify the local climate. Openings in the forest have special characteristics that make them helpful in preventing local frost. An opening with a diameter from crown edge to crown edge less than the height of the surrounding trees is as warm at night as under an unbroken crown canopy. This is from 1-5°C. warmer than an open field. By day it is probably cooler than an open field, although size and time of day have more precise effects on daytime temperatures. A larger sized opening, i.e. four times the diameter of the height of the trees, is about as likely as the open field to have radiation frost. Larger sized openings are more likely to have frost, smaller sized openings are less likely to have frost (Van Arsdel 1972).

Topographic effects

Topography has a major influence on radiation frost. Cold air flows downhill in layered flows at night something like water (with extra friction). Low places such as kettle holes fill with cold air, as do valleys. Cold air pools are often found at the bases of slopes or, on gentle slopes, on the uphill side of obstructions that make air dams. The cold air pools in valleys often turn into down valley winds, as the night progresses in mountainous or hill country.

Frost Control

Frost can be avoided in plantations by locating young trees on warm shoulders. After these trees have grown up it is possible to advance your forest edge from the established trees as the frost danger is reduced at the crown edge (Geiger 1965, Van Arsdel 1972).

More frost susceptible trees can be grown in small openings or strips less than 1:1: D:H ratio, when they are being established in an old forest or woodland.

A frosty open field can be made less frosty by establishing rows of quick growing trees like cottonwood or willow. They can be grown from cuttings.

In Canada, the Northern Lake States, and in the high mountains (spruce-fir, jack pine, lodgepole pine, and colder regions), trees often cannot become established in open fields greater in diameter than four times the height of the surrounding trees because of frequent summer frosts. To establish pines, making clear cuttings 2-3 times the tree height should limit frost and reduce daytime moisture (if pines are 60 ft. tall, then make openings 120 to 180 feet in diameter). In mountains where snow blows away, 1:1 size opening is better to prevent winter freezing.

Light

Light limits tree growth whenever a crown shades trees beneath. A common shade tree complaint for pines is "the lower branches are turning brown and dying." Remember this when you diagnose shade tree problems. There are three common maladies in which the death progresses upwards. One is shading, one is from frost, and one is from rain splashed pathogens, such as Elytroderma needle cast of ponderosa pine.

In the forest we speak of a lack-of-light injury as shade tolerance. Trees of an intolerant species are shaded out as crowns of faster growing trees close over them. The usual symptoms are browning and dying, but often the tree just produces fewer and fewer leaves until it gets below the critical level.

Turner and Aulitzky report that low light from clouds on the northern slopes of the Alps restrict tree growth in central Europe. Tolerant trees such as spruce and fir do better in such fog belts. (Hempel, 1961).

Ligntning

The long slash up the cambium spiralling down a tree where a one to four inch wide strip of bark has been ripped off is a common symptom of lightning injury. Near the base of the tree large long splinters of wood are often shattered out. Sometimes the whole tree is shattered. Some large trees are protected by lightning rods.

Drought

The symptoms for drought injury are similar to wilt diseases and changes in grade (defoliation, resprout on hardwoods). True drought symptoms must occur, but often local drought killing reports have turned out to be a fungus wilt disease (Oak wilt, Cephalosporium wilt of live oak) or other problems. Many reports of drought or scorch look like salt toxicity to me, and I wonder if the authors checked the salt content of the leaves (Tattar 1978). The symptoms that occur on unwatered potted plants do not have the predictable symptoms that some of the other described maladies do.

Winter kill or winter injury is often a reddening (or browning) of conifer needles on the part of the tree exposed to a hot drying wind when the ground is frozen. It occurs most commonly in March. The red belt disease is the best known example in the United States, it results from a Foehn (Chinook) wind blowing down the east side of the Cascade Mountains in the Pacific Northwest and drying the trees excessively. Because of the salts added to the soil along the highways with snow and ice removal which increases the water uptake problem for the trees, this symptom is more common along highways and associated drainageways.

Chemicals

Additional chemical problems are illustrated in my diagnosis paper on oaks (Van Arsdel 1978). Air pollution problems are illustrated by Jacobson and Hill (1970) and Loomis and Padget (1975). One area not adequately covered is that of browning of needles on pine trees, or browning of the terminal halves of the pine needles. These brownings are difficult to separate and identify in hard pines. They can be due to excess fertilizer, road salt, salt from irrigating water, reducing pollutants (SO_2), oxidizing pollutants (ozone,PAN). White pine needle blights can be reasonably well diagnosed from the papers of Hepting and Berry (1960) especially if aided by some from Linzon (1962, 1965).

Browning of needles is a common reaction to various chemicals, but on pines there is no general rule to separate these. Among the air pollutants there are oxidizers and reducers. Some oxidizers come from photochemical reactions. Nitrous Oxide in sunlight releases ozone. Peroxy-acetyl-nitrate is a photochemical produced from unburned petroleum hydrocarbons from car exhaust. Ozone can also come from lightning or subsidence of the high atmospheric ozone layer.

Sulfur dioxide is a common reducer. There can be synergism between the oxidizers and reducers. As a protective reaction stomata usually close in the presence of oxidizers, but SO_2 can keep the stomata open for the oxidizers to get in. To help diagnose the problems of pollutants the sources must be investigated. As an aid to diagnosis it can be noted that ozone often comes from a single event that makes the injury cover much of the growth that was present at the time of the injury. Sulfur dioxide tends to be a slower accumulation phenomenon, more localized on the leaf or needle, and often repeated. On pine needles this can produce alternating bands of injured and healthy tissue. The sulfur dioxide injury generally does not appear early in the growing season, in fact Dr. Patton called it the Fourth-of-July disease near a Wisconsin paper mill, because the injury showed up at the same time each year.

The control for pollutants is to remove the source, raise the stack height, or to use resistant selections where possible. Often there is nothing you can do.

Conclusion

Environmental diseases are common and becoming more common as man increases his numbers and his activities. Often there is little you can do about them, and prevention is usually easier than curing them. Much can be done to prevent construction injury; therefore, we need to find a way to motivate the builders. Irrigation problems, including saline irrigation water damage, can usually be solved by the homeowner. Road-deicing-salt is a more difficult problem. Some care in the handling of salty snow can help, but in many cases the only solution may be mass political action. Frost, sunscald, and certain other environmental problems can be reduced with proper practices. Air pollution is a legal and political problem for the most part, and these must be used to modify the sources. Identifying the problems can help solve some environmental diseases, others may take long slow political action by concerned citizens.

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