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NON-INFECTIOUS DISEASES OF TREES[1]

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Diseases of trees are caused by two major types of agents: 1) living pathogens and 2) non-living or abiotic stress factors. Living pathogens of trees, such as fungi, bacteria, mycoplasmas, nematodes, parasitic seed plants and viruses are well known to anyone studying tree disease. Abiotic stresses, such as extremes of temperature and moisture, nutritional abnormalities, and people-pressures from a myriad of detrimental human activities, are often overlooked as causes of tree disease. These abiotic stresses are often called noninfectious diseases.

Most shade trees exist in a high-stress environment unlike most forest trees which grow in an environment that is favorable because of natural species selection and minimal contact with people. Shade trees are usually people-planted trees, are commonly placed in the poorest imaginable sites, are exposed to extremes of weather, and are frequently contacted by people. Unfortunately, most of what we know about tree diseases comes from studies on forest trees (Roberts, 1977). Noninfectious diseases can best be understood by a closer look at some of the most common abiotic stresses affecting shade trees.

Temperature

Shade trees often must be placed near paved surfaces, which become extremely hot during the summer. The cooling effect of shade from such trees is of great benefit to people. However, trees of most species are injured by extreme heating of soil and air around trees from nearby pavement. High soil and air temperatures occur most often where trees are almost completely surrounded by pavement and are without the cooling effect of grass or mulches. Urban trees should be mulched heavily and only those species known to tolerate high air temperatures should be selected for heavily paved areas. If at all possible, landscape plans should allow for a large non-paved area around each tree to minimize the heating effect of paved surfaces and to allow air and water to reach the roots.

Tree selection for winter cold tolerance is usually based on a cold-hardiness rating. Since the widespread use of aboveground planters in many urban areas and of container stock in nurseries, many supposedly hardy species have been injured. Unfortunately, the hardiness ratings in use were prepared before the planter era and were based solely on the cold tolerance of the aboveground parts of plants, and not on the root system, which can be very sensitive to cold. The root system of woody plants is normally insulated by the soil and is rarely exposed to freezing temperatures. Soil in aboveground planters can completely freeze during prolonged periods of subfreezing temperatures, resulting in severe root injury or death of the trees in these planters. A similar phenomenon can also result from high temperatures in planters during the summer because again the insulating effect of the soil is diminished.

Clearly, trees in planters or in any aboveground containers need special attention to avoid injurious temperature extremes. If possible, during the winter planters should be placed in the ground to the soil level of the planter or should be placed in an unheated greenhouse. If the planters are

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not movable, extra mulch should be placed over the roots and also, if possible, around the entire planter. Any immovable planter should be designed with a very large soil volume, in an effort to minimize the chances of severe root injury from soil freezing during the winter.

Moisture

Water is a crucial element for determining tree growth. Tree ring studies can tell us the wet years and the dry years of ancient history. Water, however, must be in the proper quantity for plant growth; too little or too much causes injury.

Rain falls on shade trees just as it does on forest trees but after rain hits the ground the similarity ends. Forest soil, with its rich layers of humus, soaks up much of the rainwater and slowly releases it to the soil below. After the rain has stopped, the humus remains wet and continues to make water available to the trees. Consequently, the fine rootlets of the forest trees are able to absorb much of the water that falls as rain. Urban trees, however, live in another environment. The soil surface is mostly covered with impervious materials that speed runoff or with turf grass that competes with tree roots for water. In addition, soil around shade trees is often low in organic matter and compacted, causing much rainwater to run off instead of soak in. Furthermore, such soil in urban areas is often laced with drains which accelerate downward water movement and hasten drying after rains. Shade trees are, therefore, often subjected to harmful deficiencies of moisture when rainfall is adequate for normal growth of forest trees in the same region.

Improper drainage, caused by impervious materials, can also restrict water movement in soil, thus flooding or saturating the soil. This situation is common in improperly constructed planters and causes root suffocation, which kills the trees. Flooding also occurs when normal drainage has been blocked by roads, sidewalks, foundations and other obstructions to water movement which cause water to pool around a tree.

Since correct amounts of water are essential for proper growth and vigor of all trees, steps often must be taken to modify soil moisture around shade trees. Thick mulches over the soil can partially simulate the humus of the forest. The water holding capacity of the soil can be improved by adding organic matter into the soil. Watering is needed about once a week during periods when no substantial rain has occurred for 10 days or longer during the growing season and well into the fall. A slowly running hose, which is moved periodically to saturate the soil all around the tree to a depth of at least 12 inches, is ideal. It usually takes 10 to 12 hours to properly water a medium-sized tree by this method. Where excess moisture is a problem, proper drainage must be installed to carry surface and soil water away from the tree. Planters should have drains at the bottom to prevent soil waterlogging.

Nutrient Abnormalities

In the forest, most soils contain the correct balance of essential minerals needed by trees growing naturally on them. However, shade trees are almost always planted trees that may not be well adapted to the soil conditions to which they are transplanted. In addition, urban soil conditions often become modified in ways that make some nutrients unavailable to roots. This results in deficiencies. Urban soils may also be modified by the addition of high concentrations of minerals around the root zone, which can result in toxicities.

Essential nutrients can be placed into two broad categories: 1) macronutrients, consisting of calcium, magnesium, nitrogen, phosphorus, potassium, and sulfur, and 2) micronutrients, consisting of boron, copper, iron, manganese, molybdenum, and zinc, and possibly other "trace elements." Macronutrients are needed by woody plants in relatively large concentrations, and are usually added in amounts ranging in pounds per inch of stem diameter. On the other hand, micronutrients are only needed in small amounts, usually expressed as parts per million (ppm). If any of these essential nutrients is present in an abnormally high or low concentration growth of the plant suffers, and severe injury can occur if the abnormality is not corrected.

One of the most common arboricultural practices is fertilization. The common macronutrients in most fertilizers, nitrogen, potassium, and phosphorus, are added around tree roots to achieve continued growth and maintain vigor. Annual fertilization is recommended for most shade trees since often they receive too little of these essential elements from their environment in sufficient quantities for ideal growth. Leaf litter provides much of the minerals absorbed by forest trees, but usually has been removed around shade trees and has often been replaced with turfgrass, which has its own need for nutrients. Turfgrass, therefore, competes with the tree and additional nutrients are needed to keep both healthy. It has been concluded that the urban environment does not allow substantial recycling of most nutrients utilized by trees (Wilson, 1977).

Microelement availability can also be altered by modifications of the soil environment. Common abnormalities involve iron, boron, and copper. Alkaline soils high in calcium often make iron unavailable to the roots of many tree species. Since iron is involved in the production of chlorophyll, the affected leaves appear yellow-green or yellow. This "lime-induced" chlorosis can cause the decline and death of susceptible trees if not treated. Complete but temporary recovery can usually be achieved by injecting iron into the tree trunk. Laundry waste water, accidentally flushed around trees or used for irrigation in arid climates, can cause boron toxicity from borax detergents. Flushing with fresh water can correct the problem if diagnosed in early stages. On the other hand, large areas in New York and New England have boron deficient soils, where addition of a little borax improves tree health. Copper sulfate-treated burlap can cause copper toxicity injury to roots of balled and burlapped nursery stock. Runoff from copper leaders and drainpipes can cause a similar toxicity problem to foundation shrubs. After removal of the copper source, application of fertilizer with high phosphate content and regular watering will induce normal root growth and should restore vigor.

Nutrient abnormalities, like most plant diseases, are best treated in the early stages, but are often difficult to diagnose correctly in the field. Soil and plant tissue analyses are the best aids to early diagnosis and prevention of harmful nutrient stresses. Soil testing is usually available at your state university and often at no charge. In addition, assistance in making specific treatment recommendations and suggestions for further analyses, if needed, are also available at this source from the Cooperative Extension Service. A soil test before planting is a step that should be included in any list for correct tree planting, and could prevent the needless loss of a newly planted tree in the near future.

People Pressure

People are the dominant force in the shade tree environment. The detrimental pressures on trees from the activities of people are often of much greater consequence to the tree than the effects of microbial pathogens and harmful insects. People-pressure disease (PPD) is a complex and enlarging group of people-related stresses that commonly affect shade trees. PPD includes air pollution, chemical injury, construction injury, electrical injury and light pollution (Tattar, 1978) and many more factors. An examination of two common forms of PPD, chemical injury and construction injury, will illustrate how commonly these problems affect shade trees.

Trees grow best in an environment of minimal change. Unfortunately, the urban and suburban environments are usually locations where drastic changes often occur around trees, such as driveway and sidewalk installation, grade changes, road widening, and sewer trenching. Such construction activities near trees constitute a serious encroachment on the growing space of trees, which can be fatal. Since nearly all of a tree's roots are found in the upper 12 inches of soil, even the most minor soil disturbance around the tree can cause substantial root injury. Filling over roots during construction is equally harmful by causing suffocation. Roots need to respire by exchanging the carbon dioxide they produce for oxygen from the air. This exchange is essential for roots to live and to function in sap transport. When roots are trapped under impervious fill, even if only a few inches thick, they cannot respire and they die.

If at all possible, construction should be avoided around valuable shade trees. Keep as much of the root system as possible undisturbed during unavoidable construction. Any tree exposed to even apparently minor construction injury should be fertilized annually with balanced formulations, low in nitrogen but high in phosphorus, and should be watered during dry periods.

Shade trees are constantly being exposed to the chemicals we add to our environment. Some chemicals, such as fertilizers and pesticides, are beneficial to trees, if used properly, but are harmful when used improperly. Other chemicals, such as weed and brush killers, are meant to eradicate unwanted plants and must be used with utmost care near shade trees. In addition, shade trees, especially those growing along streets, are frequently exposed to deicing salts, underground gas leaks, and a large variety of spills of noxious materials, such as petroleum products and antifreeze.

Chemical injury can be minimized by the proper use of materials designed for tree therapy, and the avoidance of use around trees of materials that are harmful to trees. Education and attitude are two key factors needed to overcome this problem. Many people do not realize that, as far as therapeutic chemicals are concerned, the old adage "if a little is good more is better" does not apply. Twice as much pesticide as recommended will not make the pathogen "twice as dead" but may instead cause injury to the tree. In addition, people do not often associate many common but toxic chemicals with plant injury. For example, careless spillage of crankcase oil, gasoline, chlorinated pool water, and antifreeze can severely injure valuable trees and shrubs. The best therapy for most chemical spills is flushing with fresh water. Activated charcoal worked gently into the soil in the spill area is also effective in inactivating many persistent materials. But be careful not to cut roots when doing this.

Interactions Between Noninfectious and Infectious Diseases

Many infectious diseases, such as rusts, vascular wilts, and most leaf spots, can afflict an otherwise healthy, vigorous tree. But many others, such as diebacks, declines, most cankers, and many root rots, usually occur only after trees are already in poor health (Schoeneweiss, 1978). Diseases in this latter group often infect trees that have come under stress from noninfectious disease agents. Although noninfectious diseases can occur with little or no interaction with microbial pathogens, the presence of these "weak pathogens" is common. Also frequently on hand are secondary insects, like bark beetles which are known to be attracted by stressed or dying trees. It is important for the diagnostician not to confuse these secondary factors with the primary cause of the disease complex. When searching for a quick answer to a problem, there may be a temptation to point to an obvious dying back of the crown, or to abundant bark beetle galleries on the trunk of a tree in poor health, rather than trying to determine what initially caused the tree to lose vigor.

When you diagnose tree problems, look for conditions that weaken a tree and could have caused it to lose vigor. Be particularly suspicious when the only disease symptoms are poor growth, branch dieback, cankers, and/or secondary insects. Inquire about the history of activities around the tree(s) in question, including any site disturbances, chemicals used on the lawn and trees, or weather extremes in the last several years. Remember, the mark of a good diagnostician is the ability to tell the spectators from the players. Proper diagnosis can make the difference between misplaced efforts on a secondary problem and the alleviation of a primary stress that caused the loss of vigor and the tree's increased susceptibility to disease.

Conclusions

The environment of most urban and suburban shade trees differs drastically from the forest ecosystem, in which trees evolved. Pressures from the extremes of weather, nutrient abnormalities, and the activities of people are usually critical factors in the survival of shade trees. Therapeutic care is often necessary to alleviate or minimize noninfectious diseases, which are common to the urban and suburban tree habitat. In addition, the development of trees with increased tolerance to this unique environment is needed.

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