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HG 801

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Commercial Landscape Series: Common Abiotic Problems in Landscapes

Abiotic plant problems are not caused by living pathogens, insects, or other pests but by chemical, physical, and mechanical damage. Examples of common abiotic problems are changes in soil grade, soil compaction, changes in water flow, mechanical damage to roots or trunks, salt and fertilizer damage, poor drainage, girdling roots, improper planting, excess mulch, drought stress, herbicide damage, and air pollution.

Abiotic problems can be difficult to diagnose because often multiple factors are involved. Typical distress symptoms of an abiotic problem include very slow growth, poor foliage color, scorching, sparse growth, dieback, or death.

Woody plants can be severely affected by abiotic problems. By the time one notices that a tree or shrub is dying, it is often too late to correct the problem. That is why it is so important to recognize and prevent adverse site conditions.

White pines showing decline symptioms with browning and yellowing needles.

Decline: A tree that is in decline lacks vigor, has reduced annual tip growth and shows other stress symptoms. You may also notice small leaf size, wilt, leaf scorch, early fall color, early leaf drop, or dieback. Other symptoms include abnormally large crops of fruit or nuts and development of suckers or water sprouts, or mushrooms along the tree trunk. These symptoms usually progress over a number of years.

Oak tree with dieback and thinning foliage.

In many cases it is difficult to pinpoint the cause of decline. Decline may be triggered by a single factor, which weakens the tree and makes it more susceptible to environmental stress, or it may be caused by a combination of factors. Sudden dieback of buds and twigs, followed by other decline symptoms usually indicates that the decline is caused by a single factor, such as severed roots or defoliation by insects. A tree that shows reduced growth, along with foliar symptoms prior to branch death, is usually in decline as a result of chronic or long-term stress factors. These may include compacted soil, drought, girdling roots, salt damage, or chronic insect or disease damage.

Strategies for trees in decline depend on the extent of the decline. If stress symptoms are noticed early, careful maintenance techniques, such as soil aeration, mulching, or pruning, as needed, may improve the tree vigor. Chronic stress causing factors should be treated individually. A tree in serious decline rarely regains its ornamental value or vigor. Remove trees with severe dieback and replace with trees better suited to the site.

Stress Conditions: Stress and site problems can be caused by a number of factors including environmental stress, insect damage, and disease. Environmental stresses can be caused by severe drought, compacted or waterlogged soil, nutrient deficiencies, extreme temperature fluctuations, defoliation, winter damage, storm damage, chemical injury from de-icing salts, petroleum products, herbicides and other

Dogwood suffering from drought.

toxic materials, mechanical damage, or improper planting that results in tree roots buried too deeply, planted too shallowly, or failure to establish good contact between the roots and the soil. One or more of these conditions may cause visible symptoms, or stress may have a more subtle effect such as weakened defenses against insects or disease organisms. Plants may be predisposed to attack by pathogens or insects when they suffer stress just after planting, after storm damage, or when they begin to decline in vigor.

Ink berry hedge with dieback as a result of lack of irrigation during establishment.

Improper Plant Care: There are several factors to consider when a plant does not grow at the expected rate. It may not be fully established, it may not have received proper care, or it may be poorly adapted to the site. A field-grown tree can lose up to 90% of its root system in the transplanting process. A transplanted tree is considered established when it has recovered the root to shoot ratio it had before transplanting. Until a tree or shrub is fully established, the growth rate is slower than normal. A large tree requires a longer establishment period than a small tree, generally one year for each inch of trunk diameter. After planting and during the establishment period, a transplanted tree needs extra care. Regular watering is important to promote growth and to compensate for the reduced root system. Improper watering (too much or too little) during the establishment period is the most common cause of poor plant growth. Proper use of fertilizer, mulch, weed control, and pruning techniques also contribute to good plant establishment.

Poor Site: Conditions include a number of factors that relate to a plant's health. Site conditions that need to be considered at planting include soil texture, nutrient availability and pH, proper soil drainage, and soil moisture retention. Proximity to sidewalks, roads and buildings, exposure to temperature extremes, light exposure, wind, and air pollutants can cause significant stress on plants. Other factors that contribute to poor site conditions include construction damage, grade changes, soil compaction, and allelopathy such as proximity to black walnut trees. Select plant material adapted to the specific climactic zone or adapted to specific sites such as seashore, urban, or woodland

Site prone to flooding affecting tree on right.

Compacted soil, poor soil quality.

areas. Proper site preparation and selection of high quality plant material will help plants adapt to a difficult site.

Trees may exhibit poor growth when they are not well adapted to a site. When you are selecting plants for a site, consider existing conditions such as soil texture, soil drainage, pH, exposure to air pollution, temperature and wind extremes, as well as proximity to sidewalks, roads, and buildings. Choose trees that are able to tolerate existing conditions. It is difficult to change existing environmental conditions, but a tree may resume normal growth if specific site problems are identified and corrected.

Dogwood planted in compacted soil with reflected heat from adjacent building. No follow up irrigation.

Excessive mulch placed around tree trunk.

Girdling roots and surface roots.

Excess Mulch: Mulches in general are beneficial to plant growth, however if too much is used it may be detrimental to plants. Keep mulch several inches away from the trunk to prevent excessive moisture and the possibility of crown rot diseases. Mulch should not exceed three inches in depth. Although organic mulches break down over time they should only be replaced as needed to maintain their original depth. Excessive mulching may encourage certain plant species to establish roots in the mulch layer rather than the soil underneath. Over time this can lead to root death due to desiccation during dry weather as the mulch dries out more quickly than the soil. Irrigation of mulched plants should be carefully monitored for water percolation through the mulch layer into the soil. Insufficient watering may only wet the mulch layer while the soil remains dry. Excessive mulch may delay the onset of dormancy in the fall by keeping root zone temperatures warm. In contrast excessive mulch may prevent the breaking of dormancy in the spring due to cooler root zone temperatures.

Girdling root cutting off water movement up the tree.

Girdling Roots: Girdling roots grow in a circular or spiral pattern. If left unchecked they eventually cut off the sap flow from the stems and leaves. They may form in root bound container grown plants, begin when a tree is transplanted, or develop as a tree grows. Poor planting techniques, deep mulch, or compacted soil seem to encourage the development of girdling roots at the base of the trunk. As roots circle the trunk, they can physically crush the cambium in the lowest part of the trunk and cut off the flow of sap in the tree. Carbohydrates produced by the leaves, through photosynthesis, are unable to move through the phloem to the roots. Weakened roots are unable to provide adequate water and nutrients to the leaves. Trees with girdling roots tend to decline over a 5-10 year period. Any species can develop girdling roots.

Symptoms associated with girdling roots are caused by a weakened root system. The crown of the tree may be thin, with stunted growth. Leaves may be lighter green, scorched, show early fall color, and early leaf drop. Twig or large branch dieback can occur. When one side of the trunk is straight, with no natural flare, digging may indicate a girdling root below the soil surface at that location. Trees with severe girdling roots may lean or completely break off. Reduced sap flow makes the tree more susceptible to insects, disease and environmental stress.

Treatment of girdling roots begins with prevention. When planting, loosen and straighten circling roots or remove them. Be sure the planting hole is wide, allowing ample room for the root system. Do not smooth or compact the sides of the planting hole, which may deflect roots and lead to girdling. The sides of the planting hole should be loose and roughened, to allow root penetration into surrounding soil. Be sure plants are planted at the proper depth and mulched lightly.

Inspect properly planted trees regularly to detect girdling roots while they are small. Small girdling roots can be removed with a sharp chisel and mallet. Remove several inches of the root where it contacts the tree trunk, to ensure the root does not reconnect. If a large girdling root has grafted with the tree trunk, it is advisable to allow it to remain undisturbed. Cutting a V shaped notch in the top half of the girdling root may help to weaken it without disrupting the vascular flow to the top of the tree. No treatment of cut roots is necessary. Seriously weakened or declining trees may need to be removed.

Grade change due to construction.

Grade changes: Adding or removing soil over tree roots can seriously damage them and jeopardize the health of the tree. Increasing the soil depth over tree roots changes the oxygen exchange between the roots and the soil surface, causing dieback of tree branches. Additional soil may also affect the permeability of water to the root system. Clay soils cause the most injury because their fine texture blocks the movement of air and water. Decreased oxygen levels are a common problem with clay soil additions of more than an inch. The deeper the fill, the more severe the damage. Up to several inches of gravely or sandy soils may cause fewer problems since water and oxygen permeate them more readily. However the addition of fill over existing soil will lead to a problem with layers of soil of differing textures. This condition will cause drainage, temperature and air exchange differences that may cause root problems in the existing soils. Slow warming of soil the next spring along with low oxygen levels may lead drought damage by mid-summer. Diseases such as crown rot may develop if the trunks of certain tree species remain moist due to increased soil moisture retention.

Lowering the grade may be as disastrous as raising the grade around trees. Most tree roots occur within the top 18"of the soil profile, and most of the feeder roots are within the top six inches. Lowering the grade around trees will lead to root loss due to removal of the small feeder roots that are present in the upper layers of soil. Soil removal will also expose the remaining feeder roots to fluctuations in temperature that may lead to root death. Severed and weakened roots will not be able to perform functions such as anchorage, water transport or nutrient absorption.

Trees very sensitive to grade changes	Trees less sensitive to grade changes	Trees least sensitive to grade change
sugar maple, beech, dogwood, oak, tulip tree, pines, spruce	birch, hickory, hemlock	elm, poplar, willow, planetree, pin oak, locust

Compacted soil due excessive foot traffic.

Compaction: Compacted soil can lead to tree decline. A tree that is in decline lacks vigor, has reduced growth and shows other stress symptoms, such as wilt, scorch, early fall color, and dieback. These symptoms usually progress over a number of years. Soil compaction may be the result of foot traffic, heavy equipment, or any activity that applies pressure to the soil. Tree roots grow in the pore space between soil particles. In compacted soils overall pore space in the soil is reduced, resulting in decreased oxygen and moisture capacity in the soil. Fine roots have difficulty penetrating the compacted soil. Poor root growth reduces the plant's ability to take up nutrients and water, results in less vigorous growth and makes the tree less resistant to environmental stress. Roots also tend to grow closer to the soil surface in compacted soils, resulting in greater exposure to temperature fluctuations and greater vulnerability to drought.

Correction of soil compaction is difficult. Cultivating the soil to incorporate organic matter is not recommended in areas with existing trees. The process of vertical mulching is the best method of aerating soils adjacent to tree roots. Use an auger to drill holes 2-3 inches in diameter, 12 inches deep in the root zone area. Holes should be made at 2-3 foot intervals, starting midway between the trunk and the drip line of the tree, and extending beyond the drip line of the tree. Fill the holes with finely ground pine bark, compost, or peat moss. These products increase pore space in the soil and allow greater root growth in the area. Air-spading may also be used to fracture compacted soil without removing it. Air-spading is often done in small "pie slices" underneath a tree canopy and backfilling them with a mix of native soil and organic matter.

Prevention is the best way to avoid compacted soil. Keep foot traffic to a minimum, using defined pathways to direct traffic. Fence areas around trees during construction projects to keep heavy equipment away. Use double, overlapping plywood sheets to protect the soil surface, if the use of heavy equipment is unavoidable. A 3-inch layer of organic mulch also helps to prevent soil compaction.

Poor pruning resulting in excessive water sprouts.

Pruning: Water sprouts are vigorous, usually upright shoots developing from dormant buds on the trunk or large branches of a tree. In many cases pruning or removal of large branches stimulates dormant buds into growth. Heavy pruning results in more sprout production. Stress can also stimulate growth of water sprouts but they are usually less vigorous than those stimulated by pruning. Suckers are similar to water sprouts but originate from the roots or the trunk below the graft union.

Water sprouts should be removed promptly. Check the tree regularly and simply rub off new shoots as they emerge. Large water sprouts can be pruned off close to the trunk. Allowing water sprouts to remain can ruin the tree's shape and divert energy from the rest of the tree. You may choose to train one or more sprouts to replace any missing branches.

Improper pruning of spring flowering shrubs may result in removal of flower buds. Pruning at the wrong time can result in uneven flowering if some, but not all, flower buds are removed. Most spring flowering shrubs set flower buds in midsummer and should be pruned by the end of June. Lilacs should be pruned immediately after flowering. Timely pruning will allow new growth to mature enough to form flower buds by late summer. Excessive pruning can result in failure to flower. Pruning is considered excessive when more than one third of the branch structure is removed at a time. This type of pruning stimulates vegetative growth and results in little or no flower bud formation.

Close up of water sprouts.

Severed roots due to sidewalk and road construction.

Construction Damage: Trees can be severely marred or even killed by certain construction practices, some of which are unavoidable. If you are aware of these situations before they occur, damage to trees may be kept to a minimum.

- Site a new home carefully. Make use of existing trees and avoid excessive grading.
- Protect desirable trees by using fencing and clearly marking them.
- Consult a landscape professional to review your plans and assess your property before any clearing begins.
- Once an area is disturbed look for the following problems:
- Poor grading around trunks: If tree roots have been exposed, a 2- to 4- inch layer of fertile loam may be applied over them. If more than 4- inches of soil have been piled around the base, attempt to reduce it. Otherwise, the tree may die from lack of oxygen to the roots.
- Compaction by heavy equipment: Soil immediately around trees may be seriously compacted as trucks and equipment pass by. There are no mechanical corrections for this problem. The impact of heavy equipment may be minimized by using steel plates to distribute the weight over a larger area or by limiting access to times of the year when the ground is frozen or dry.
- Damage to bark and limbs: Broken tree limbs should be clearly cut at the branch "collar" on the trunk.
- Root damage from trenching: Any excavating may damage roots of nearby trees. Directional boring should be utilized if utilities must be placed under the canopy of existing trees.

Mechanical damage due to rubbing branches.

Mechanical Damage: Scattered dieback throughout the tree may be a result of mechanical damage. When equipment or machinery bangs into the trunk, it can crush the cambium layer or tear off bark. Repeated bumping of the trunk, especially in young trees, can severely damage or kill sections of the cambium layer just below the bark. Sap flow is interrupted between the roots and leaves, causing some twigs or branches to die. Mechanical damage also opens the tree to disease organisms, which may further damage the tree. Lawn mowers, tractors and string trimmers are the primary cause of mechanical damage to the tree. Trees planted near parking lots, driveways or roads are also vulnerable to damage from cars bumping into the trunk.

Trees are particularly susceptible to trunk damage in spring and early summer. While the tree is actively growing the bark is somewhat loose, and is likely to slip when bumped. Avoid mechanical injury by maintaining a mulched weed free area around the tree trunk. Provide protective sleeves if vulnerable young trees are planted where they are subject to string trimmer or mower damage.

Embedded fence wire.

Embedded hose and wire tree supports.

Embedded Wires, Labels, or Collars: Tree trunks may be deformed or girdled when hose and wires, ropes, or wire basket collars are not removed. The most common staking method consists of two wooden stakes supporting the tree with hose and wire around the trunk. The stakes, hose, and wire should be removed after the first year. Hose and wire or synthetic ropes left on the tree can interfere with the proper growth of the tree. As the trunk grows, the wires can cut into the trunk, restricting or cutting off sap flow. As the trunk caliper increases, the trunk can grow around the wires, causing them to become embedded in the trunk. The tree may also have increased trunk diameter above the wires and be more prone to breakage. Tags or labels that are left around tree trunks may also become embedded in the trunk.

If partially embedded wires are noticed, remove as soon as possible. If the trunk completely encases the wire, it may cause more damage to remove it. Trim excess wire, remove stakes, and monitor the tree, realizing that it will be prone to breakage at the site of the embedded wire.

Wire baskets are used on the root balls of large trees to make them easier to handle. Roots can be girdled when the wire basket is not removed at planting time. All wire should be removed from the rootball at planting time.

Recent research has indicated that trees become established faster when they are not staked. Unstaked trees have better trunk growth and develop a more extensive root system. Staking trees when they are planted is sometimes necessary, especially in areas where trees may be knocked down by wind or vandalism. Staking is still required in many commercial landscape contracts. Proper planting techniques and removing stakes promptly can avoid problems associated with embedded wires.

Salt damage to trees due to road salt spray.

Damage to spruce trees due to uptake of soil applied herbicide.

Deicing Salt /Fertilizer Damage: Significant damage from deicing salts can occur on trees and shrubs planted along roadways and sidewalks. Evergreens exposed to salt spray at the seashore can also exhibit salt damage. Many fertilizers contain salts that can burn plants if over applied. Salts injure foliage and roots by drawing water out of the tissue, killing the cells. Needle tips will turn brown and become brittle. Deciduous plants will exhibit marginal leaf browning or leaf scorch Repeated exposure can cause deformed growth and eventual bud, twig and branch dieback. Premature fall needle coloration may also be symptomatic of salt injury on evergreens. Damage due to excessive fertilizer application generally appears as marginal leaf browning or leaf scorch.

Close up of salt damage.

Soaking the affected area with one-inch applications of water three to four times in the spring can often treat plant damage. Gypsum may be added to the soil to reduce high sodium levels caused by excessive amounts of rock salt. Soil replacement may be an option for small planting beds.

Herbicide Injury: Herbicides are products designed to kill undesirable weeds, however misapplied herbicides can cause injury to desirable landscape plantings. Symptoms of herbicide injury can often be confused with other cultural or environmental, insect, mite, disease problems and other pesticide injury. Diagnosis is often difficult because information about specific symptoms on ornamentals is limited. In addition the dose received by the plant and how it was applied will often influence symptom expression. Some herbicides are more readily absorbed through plant roots while others are only absorbed through leaf and stem tissue. Tissue and soil analysis for herbicide residues is often not available, is impractical or is very costly.

Close up of pine herbicide damage

Symptoms of some commonly misapplied herbicides:

- 2,4-D and MCPP: Twisted and bent shoots and petioles
- Dicamba: Dwarfed, distorted and discolored foliage
- Glyphosate: Plants stop growing, remain green for several days, may develop yellow leaves, then turn to uniform brown; plants treated in the fall may not show symptoms until the following spring.

- Trifluralin: Roots may be swollen or club shaped, roots may appear shortened with fewer secondary roots present.

Damage to burford holly due to uptake of soil applied herbicide.

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