Diagnosing Plant Problems - An Analytical Approach

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This article is the fifth and final installment in a five-part series of articles on diagnosing plant problems. The goal of these articles is to provide you with some guidelines for determining the causes of plant problems. This information will apply mainly to landscape plants, but it should also be useful for indoor plants. Some of the information in this series of articles has been adapted from extension publications from Oregon State and Washington State Universities. In the first two articles, plant stress and the five-step diagnostic process were discussed. In the third and fourth articles, some characteristics of biotic (disease and insect) problems and abiotic (construction and environmental) problems were covered. In this final article, plant problems due to nutrient deficiencies and chemical toxicities will be discussed.

Additional Nonliving Factors

As described in the fourth article of this series (see the January/February 2003 issue of the *Taproot*), nonliving factors can damage plants or even kill them. These factors are considered noninfectious since the damage remains on the effected plant rather than "spreading" from plant to plant. Many nonliving factors, such as nutrient disorders and chemical toxicities cause noninfectious disorders. As with construction damage and injury due to extreme weather, damage to plants caused by chemical toxicities will typically be seen on several species or genera of plants in a mixed planting bed or field. The damage from noninfectious factors may show as a pattern on groups of plants. The damage is often uniform and repeated from plant to plant. Some chemical toxicities and nutrient disorders can cause similar plant symptoms, so closely examining plants for additional clues along with asking plenty of questions will help you to make the correct diagnosis. Experience and familiarity with the particular plant species or cultivar will be very useful when diagnosing noninfectious disorders, such as nutritional and chemical problems on plants.

Mineral Disorders on Landscape Plants

Plants need minerals, also called nutrients, to survive. Sixteen minerals are considered essential. The minerals needed in large amounts by plants are carbon (C), hydrogen (H), oxygen (O), nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), and sulfur (S), and these minerals are referred to as macronutrients. The minerals needed in small amounts by plants are boron (B), molybdenum (Mo), chlorine (Cl), iron (Fe), zinc (Zn), manganese (Mn), and copper (Cu), and these minerals are referred to as micronutrients. Too little of any of these nutrients in the soil can cause deficiencies in plants, yet too much of any of these nutrients in the soil can cause toxicity problems for plants. Although plants can have mineral toxicity problems, only nutrient deficiency problems will be discussed in this article.

Mineral deficiencies in plants can be difficult to diagnose, but examining the foliage or growth on the plant helps in determining which nutrient may be affecting the plant. Determine where the leaves or growth (shoot tips) are affected on the plant. In particular, the new leaves or growth and old leaves on the plant should be examined for abnormal growth or appearance. All minerals are taken up from the soil by the roots (except for C, H, and O) and transported via the xylem tissues to the various parts of the plants. When a plant is unable to take up enough of one or more minerals, certain minerals already incorporated in plant tissues can be re-mobilized from less active tissues, usually the lower foliage, to more active tissues, usually upper leaves and stem tips. This reallocation makes sense since lower leaves are often shaded and so conduct less photosynthesis compared to upper leaves that receive more sunlight and are capable producing more sugars for the plant. Unfortunately, certain minerals are immobile in the phloem, meaning the minerals are unable to be removed from lower leaves and translocated to the more active upper leaves on the plant. For this reason, a nutrient deficiency for any phloem-immobile mineral usually shows up first on the new foliage or growth (shoot tip). Mineral deficiencies caused by inadequate amounts of S, Fe, Zn, Cu, or Mn are usually seen first on the newer leaves on a plant. Likewise, a B or Ca deficiency causes the shoot tip(s) on a plant to die back. In contrast, mineral deficiencies caused by N, P, K, Mo, or Mg are usually seen first on the older foliage or leaves. These minerals can be phloem translocated (actually re-translocated) from lower leaves to other more active leaves on a plant, so the mineral deficiency will show up first on the lower leaves. A classic nitrogen deficiency seen on tomato plants about one foot tall can be described as the new leaves having a moderate green color, but the lower (older) leaves are yellow or yellow-green.

A key to nutrient deficiencies on landscape plants is included in this article (Table 1). Keep in mind that the descriptions in this key are general descriptions for landscape plants. Particular species may respond differently to certain mineral deficiencies. For instance, sulfur in some plants can be re-translocated from older leaves. For this reason, the deficiency would show up on lower leaves first rather than upper leaves as described in the key (Table 1). Experience will be helpful for identifying the deficient mineral. Completing a foliar mineral analysis will help you determine the exact deficiency, particularly since Fe and Mn deficiencies may be difficult to distinguish from each other. A soil analysis would compliment a foliar mineral analysis and should help to determine the cause of the mineral deficiency. The cost of a foliar mineral analysis can range from $20 to $60, depending on the laboratory and the types of minerals that are analyzed.

Excess quantities of minerals can cause toxicity problems for plants. Some soils, particularly in the western US, have high pHs and high levels of sodium. These soils are called sodic soils. Besides having poor physical qualities, such as impermeability to water and air, sodic soil contains too much sodium (Na) for many plants to tolerate. Too much road salt, typically sodium chloride (NaCl), spread over pavement to de-ice the surface can cause toxicity problems for plants due to the Na in the salt. Other salt formulations, such as potassium chloride (KCl), are less harsh for landscape plants compared to NaCl. Applying too many micronutrients when fertilizing plants can cause micronutrient toxicities. The quantities of fertilizer applied should be carefully calculated and applied as accurately as possible, meaning the fertilizer spreader should be calibrated and used properly.

Table 1. KEY TO NUTRIENT DEFICIENCIES OF LANDSCAPE PLANTS

To use this key, determine the specific location of the affected plant tissue, then go to the appropriate section, either A, B, or C.

A. Older leaves affected first

A1. General chlorosis progressing from light green to yellow; stunting of growth, excessive bud dormancy; necrosis of leaves, followed by abscission in advanced stages - **Nitrogen**.

A2. Marginal chlorosis or mottled leaf spots which occurs later; tips and margins may become necrotic, brittle and curl upward - **Magnesium**.

A3. Interveinal chlorosis with early symptoms resembling N deficiency; leaf margins may become necrotic and may roll or curl - **Molybdenum**.

A4. Leaf margins may become brown or mottled and curl downward - **Potassium**.

A5. Leaves accumulate anthocyanins causing blue-green or red-purple coloration; lower leaves may turn yellow - **Phosphorus**.

B. Youngest leaves affected first

B1. Light green color of young foliage, followed by yellowing; tissue between veins lighter colored - **Sulfur**.

B2. Distinct yellow or white area between veins; initially veins are green, becoming chlorotic under severe deficiency, followed by abscission - **Iron**.

B3. Necrotic spots on young chlorotic leaves, with smallest veins remaining green - **Manganese**.

B4. Chlorotic leaves abnormally small; shortened internodes in severe cases, becoming rosetted - **Zinc**.

B5. Young leaves permanently wilted becoming chlorotic, then necrotic - **Copper**.

C. Terminal bud dies

C1. Brittle tissue, young or expanded leaves becoming chlorotic or necrotic and cupped under or distorted; terminal and lateral buds and root tips die - **Boron**.

C2. Growing points damaged or dead tips; tips and margins of young tissue distorted; leaves may be come hard and stiff - **Calcium**.

In summary, the key to determining mineral deficiencies in plants is to examine the plant for symptoms and to determine if the new or old leaves are affected. Although symptom keys are available, deficiency descriptions may vary from species to species. A foliar mineral analysis should be completed to help determine the exact mineral deficiency.

Chemical Toxicity

Many types of chemicals can be applied to plants to promote their growth and help them thrive. Fertilizers, pesticides, and growth regulators are a few of the types of chemicals used on plants to promote their growth or health. A chemical applied at too high a concentration or unintentionally (due to drift) can harm or damage plants. Unfortunately, plant symptoms from chemical damage sometimes appear similar to those caused by other factors, such as weather or nutrient deficiencies. Groups of damaged plants in a field or landscape or individual damaged plants need to be carefully examined to determine if a chemical toxicity is involved. Examine plants to determine if the damage resulted from an aerial application or a root application.

Chemicals can damage entire groups of plants in a field or landscape. In general, if several species or genera of plants are damaged, the causal agent could be a chemical. Keep in mind, however, the environment or management practices can also affect many types of plants in a mixed planting. Examine plants in an area for a pattern of damage. For instance, look for groups of plants damaged from drift or accumulating runoff in low-lying areas. Does the damage diminish uniformly from one side of the plant to the other? If damage on a group of plants in a yard or field starts on one side of the plants and gradually diminishes on the other side of the plants, chemical droplets that drifted in the wind may have caused the problem. Is damage seen in stripes at regular intervals in the lawn or field? Irregular application or overlapping application of a chemical can cause recurring stripes of damaged plants. Is damage seen at the edges of a field or lawn when a sprayer or spreader would have been turned around or started and stopped often? If you notice damage intensity increasing along a broad band in a field, perhaps a wettable powder in a spray tank was inadequately mixed or poorly agitated, resulting in an increased concentration of chemical applied as the tank is sprayed out. Maintaining records of applied chemicals will help in the diagnostic process.

Individual plants should also be examined for injury symptoms. Chemicals applied to the root system can be absorbed and distributed through the vascular tissues, the xylem for some chemicals or the xylem and phloem for other chemicals. Chemicals applied to the root system usually have a systemic effect, damaging either the entire shoot or portions of it. Shoot symptoms from chemical damage can include nutrient deficiency, wilting, or stunted growth. Typically, the amount of the shoot affected relates to the amount of the root system exposed to the toxic chemical. If a chemical is transported only in the xylem tissue, it moves upward in the plant. Damage from xylem-translocated toxic chemicals is usually seen first in the older foliage, with damage appearing on the leaf margins or interveinal areas. Xylem-translocated chemicals, however, can also damage new foliage, and leaf veins are often damaged on young immature leaves by these types of chemicals. Phloem-translocated chemicals can move in the xylem or phloem tissues, allowing the chemicals to move either up or down in the plant from the point of application. These chemicals can damage roots or shoots. Phloem-translocated chemicals usually cause toxicity symptoms on the new growth and meristems (root and shoot tips) on a plant. The herbicides 2,4-D, dicamba, and glyphosate are phloem-translocated herbicides that are translocated to the meristems, injuring the youngest tissues of a plant.

Aerial application of chemicals, whether intended or accidental (spray drift), can cause contact damage over the entire plant canopy. Damage to the leaves may be in a pattern of spray droplets. Herbicide drift, roadside salt spray, foliar fertilization, and phytotoxic pesticides can cause damage in a droplet pattern. The damage may be mild resulting in chlorotic spots or severe actually killing small areas of the leaf or stem. Foliar damage may also be seen where the chemical (spray) accumulates on the leaf margin (edge). For example, the plant growth regulator Cycocel® may discolor the leaf margins of certain geranium cultivars where it accumulates after it is sprayed. Air pollution or volatile chemicals often kill tissues between the leaf veins and along the leaf margins. This damage pattern on the leaves is the result of lower water concentration in tissues farthest from the roots (source of moisture).

Toxic chemicals and nutrient deficiencies can cause similar symptoms on plants, complicating the diagnosis. For instance, some photosynthesis-inhibiting herbicides can cause leaf chlorosis symptoms similar in appearance to an iron deficiency. Scorching of the margins on leaves can be due to air pollution, such as sulfur dioxide, or excess sodium in the soil. Again, experience in diagnosing plant problems will be helpful in making the correct diagnosis.

Diagnosing plant problems caused by mineral disorders or toxic chemicals can be difficult. Maintaining a logbook on fertilizer and pesticide applications will help in the diagnostic process. Plants in a large area or field should be examined for an overall pattern of damage. Individual plants should also be examined. Both new and old foliage should be examined, since the leaves on certain parts of the plants can provide clues about the cause of the damage. This last article in the series covered a few of the problems caused by nutrient deficiencies or toxic chemicals. The purpose of this series of articles has been to provide you with some information on how to start the diagnostic process. The five step diagnostic process should be used to narrow down the number of factors that can cause plant problems. Gathering as much information as possible throughout the diagnostic process will certainly help you in making the correct diagnosis. If a problem has you completely puzzled, consult with your county extension educator or a green industry professional. This series of five articles will probably not make you an expert diagnostician, but they are intended to provide you with information to help you as you gain experience and confidence in diagnosing plant problems.