OAK PATHOLOGY—USING LEAF SYMPTOMS TO DIAGNOSE RECONDITE MALADIES[1]

by Eugene P. Van Arsdel

This paper describes the use of leaf symptoms as an aid to the diagnosis of those hidden maladies undetectable by the usual discrete symptoms found with cankers and leafspots which are readily diagnosed by most plant pathologists and foresters. Under consideration are those diseases with hidden causes that are difficult to differentiate, such as nutrient deficiencies, root suffocation, air pollution, excess salts, vascular wilt diseases, and root rots. In general, the symptoms described will be as they are found in Texas, but their applications can often be made in other areas.

The leaf symptoms resulting from various maladies are often similar; therefore, proper diagnosis requires the use of other information, such as histories, extent of the occurrence, the appearance of the crown, whether the butt swell at the ground line is covered by soil, whether the problem includes more than one species of plant, and the like.

A number of books and papers have been written from the opposite point of view. The cause is presented, and then a descriptive list or pictures of the symptoms are presented; *e.g.* deficiencies are described by Sprague *et al* (1964), air pollution by Jacobson and Hill (1970), various diseases by Pirone (1978), copper toxicity by Kuhn and Sydnor (1976), virus diseases and deficiencies (USDA 1951). The type of information being presented here can be used to make a key for the diagnosis of the maladies. Carter (1964) presented a pictorial guide to certain types of leaf symptoms. He illustrated scorch, chlorosis, curling (2,4 D), and dark brown blotches along the edge (fertilizer burn). His approach was midway between that of those tested earlier, and my approach, which is to present the leaf symptoms so they can be used as a key to the maladies. While the information is not enough to make a complete key, hopefully it is a larger array than has been previously gathered.

Most of the problems we are concerned with in urban forestry are parasitic diseases or environmental diseases. The parasitic diseases (wilts, cankers, leafspots, wetwood) are caused by living organisms; the environmental diseases are caused by continuing injuries imposed on the trees from its surroundings. The various problems overlap and each contributes to the other. For example, trees infected with the oak decline fungus (*Cephalosporium diospyri* Crandall) already have problems getting water from the soil to the leaves because of the vessels being plugged by the wilt organism and host reactions to the fungus. Any additional injury to the roots such as suffocation from earth fill, soil compaction, or the cutting off of the roots affects these trees much sooner and more seriously than those not infected with the fungus. Similarly, trees infected with the decline fungus, or with the roots injured during construction are much more susceptible to *Hypoxylon atropunctatum* (Schw, ex. Fr.) Cke. and *Endothia gyrosa* (Schw.) Fries cankers than uninjured noninfected trees.

Often the identification of a problem provides the means for the cure. Yellowed leaves on more than one type of plant, indicates that a gas leak was the cause, so the cure of repairing the leak and pumping air through the soil to exhaust the gas becomes obvious. It may also be that diagnosis indicates that there is nothing that can be done, such as building a house around a tree with the hope of creating a shady courtyard, but where the footings for the walls have created a dam and the tree has already flooded out.

Only some of the most commonly found deficiencies, salt injuries, and air pollutants are included in this key; for more detailed descriptions of deficiency diseases see Sprague *et al* (1964); and for air pollutants see Jacobson and Hill (1970) and Loomis and Padget (1975). Where

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the symptoms described have been taken from the work of others, literature citations have been made. Where the symptoms have been made as a result of my own tests and observations, they are presented here without the supporting data; however, chloride tests have been made, gas leaks have been detected, and weed killers have been chemically analyzed in the leaves.

KEY TO THE SYMPTOMS

The diagnosis of the tree problems from leaf symptoms of leaves that are part green is based upon the following: color, pattern of discoloration, the texture of the margin of the discoloration (gradual, abrupt, or with modifying colors), leaf size, distortion or curling, etc. Different species of plants may turn different colors from the same cause; *e.g.* potasium deficiency symptoms include a yellowing of the leaves on citrus, but produce a reddening or purpling on apples, and magnesium deficiency appears yellow on most plants but advanced stages are red in blueberries (Sprague, Barber *et al* 1964).

LEAVES WHITE, CREAM OR BUFF

Frost (definite edge injury, tending to be along the outer edges of the peripheral leaves and tending to be away from the petiole end of the leaf, blotchy patterns with generally rounded shapes to the blotches, pattern not greatly influenced by the veins in the leaf (fig. 1).

Weed killers (DSMA and MSMA are reported to look "just like frost" when woody plants are injured).

Air Pollution — reducers, SO_2 (blotchy, on various parts of the leaves, usually interveinal with the veins staying green, injury on both sides of the leaves, a definite edge on the discolored spots).

Triazine weed killers (tends to be peripheral and interveinal, with the margin of the discoloration rather gradual; example is from atrazine as an air pollutant; fig. 2).

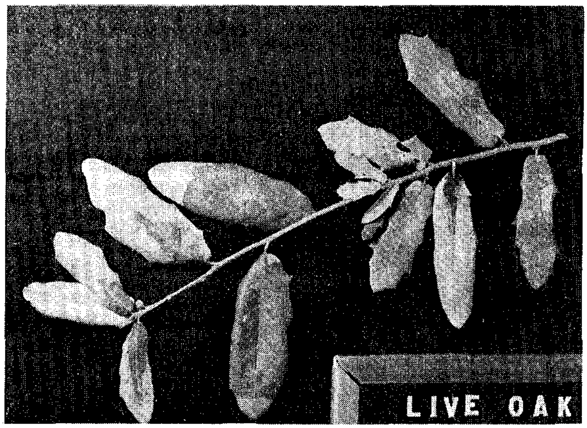

Figure 1. Frost injury on live oak. A creamy white discoloration on a green leaf.

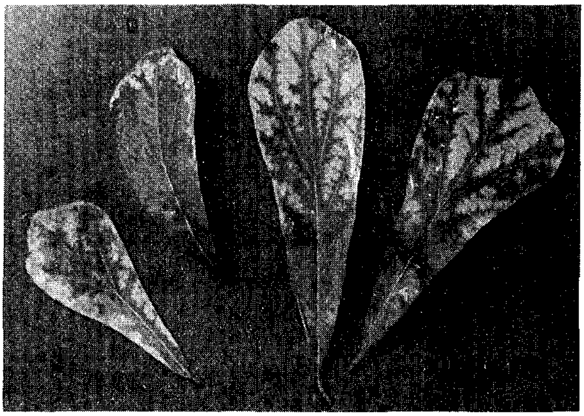

Figure 2. Yellow or cream discoloration on green leaves. Caused by atrazine on water oak. Dark spots are from mechanical injury in the laboratory.

LEAVES YELLOW-GREEN OR YELLOW

GENERAL YELLOWING

Root suffocation (sometimes green borders remain along the veins) is caused by the following:

Earth fill over the original soil containing the tree roots. Proper fill procedures are outlined in Fowler and Gravatt (1945) and Pirone (1978).

Daily watering (too frequent watering may keep the soil flooded, or waterings that are too frequent and too light may keep the surface sealed so there is no air exchange with the root zone).

Gas leaks (usually a general yellowing, but at times there is a peripheral discoloration with the yellowing extending into the interveinal spaces (fig. 2); often there is a chlorotic mottling); My observations of heating gas injury agree with those of Marsden (1950-1951).

Compaction (bus stops, pedestrian pathways, cattle standing under shade trees). Often mottled, and green around the veins.

Interrupted drainage (dams in streams or draws, construction of walls across drainage lines such as in building courtyards around a tree, also road construction damming water flow).

PERIPHERAL YELLOWING with the yellow from the leaf margins tending to extend into the interveinal spaces (fig. 2).

Deficiencies

Magnesium deficiency (pronounced interveinal yellowed zones, or in advanced cases only the tissues along the veins are green; common along the Gulf and Atlantic Coastal Plains where the parent rocks did not contain magnesium (Walker 1969); the oldest leaves turn yellow first, the younger leaves rob the old ones of magnesium to keep their chlorophyll operating and to stay green).

Zinc deficiency (general yellowing, usually the vein borders remain green, leaves are smaller, the internodes are shorter, the plant has a bushy appearance; common on alkaline soils; affects new leaves the most).

Iron deficiency (general yellowing, or vein borders remain green; growth spindly, affects new growth the most; found in alkaline soils, on caliche outcrops and the like).

Manganese deficiency (especially found on leaf margins and interveinally similar to magnesium, but found on new leaves, unlike Mg; reported in Michigan on declining maples (Kielbaso 1976).

Herbicides

2,4 D injury's most notable symptom is curling and deformity (fig. 3), but there is yellowing, and often brown spots.

Triazine herbicides may be white, cream or yellow; it tends to be a marginal injury with interveinal fingers reaching toward the midrib. Often found in specialized lawn fertilizers.

Oil sprays (mosquito control and the like) make yellow and brown spots on the leaves.

Air pollutants — oxidizers, fluoride and chloride. (Low-level fluoride injury is reported to cause peripheral yellowing with fingers reaching between the veins towards the midrib similar to fig. 2 — Loomis and Padget 1975 — but chloride injury from irrigation water in Texas and de-icing salt in Michigan produce a brown marginal burn with an abrupt edge and generally no intermediate area of yellow pigment — chloride is listed under brown discolorations.)

Figure 3. 2,4-D injury on cottonwood.

LEAVES ORANGE-YELLOW OR RED-BROWN — discoloration centered around the midrib and the petiole end of the leaf.

Copper Toxicity. (Orange to red-brown found in basal and central part of the leaf.) This opaque pigmentation, easily seen by transmitted light, has been associated with high copper content (10 ppm) in leaves. It is similar to that shown for cotoneaster by Kuhn and Sydnor (page 72, 1976). (Fig. 4).

This symptom has been found where live oaks have been sprayed with copper hydroxide to kill ball moss (*Tilandsia recurvata*), but live oaks seem to be accumulating copper from high-mineral-content shallow-limestone soils on the Eagle Ford and Woodbine geological outcrops.

LEAVES TAN, LIGHT BROWN, OR RED-BROWN with a gradual margin on the discolored leaf. Largely biological.

Oak decline (caused by the wilt fungus, *Cephalosporium diospyri*; when leaf symptoms are present the outer half of the leaf, away from the petiole, is often tan to red brown; fig. 5).

Root and basal sapwood rot from Polyporus dryophylous on live oak causes a red-brown blotchy interveinal discoloration with gradual indefinite edges on the discolored portions of the leaves.

LEAVES LIGHT BROWN TO DARK BROWN with an abrupt edge on the discolored part.

Perimeter ring all around the leaf discolored and necrotic (fig. 6).

ANIONS OF TOXIC SALTS, excess salts, and certain organic compounds (Generally a lighter brown than fertilizer burn.)

Chloride injury (Sodium chloride; builds up from irrigation water in Texas, from salt to melt ice on roads; especially where snow plows accumulate much ice, snow, and salt near corners; Phosphorus Trichloride air pollutant caused the same symptom; Fig. 6).

Sodium arsenite (used as an edging weed killer).

Lead arsonate used to kill ball moss on live oaks.

Dimethylformamide (used as a solvent to treat trees with a systemic fungicide in Texas) (Fig. 7). Prometone (an herbicide used to kill weeds on roads and driveways) commonly makes an injury that looks much like DMF on some of the leaves, but there is a great deal more variation between leaves.

Gasoline and *kerosine*, used as local contact herbicides, the oaks survive with a perimeter ring injury.

Outer one half of the leaf dark brown with an abrupt edge and a tendency to have a perimeter ring burn that extends part way down to the base of the leaf.

Excess nitrogen fertilizer (fig. 7). On deeply lobed red oaks the points have the dark brown discoloration, the sinuses between the lobes are free of the discoloration, unlike chloride injury where the sinuses between the lobes have a more or less continuous marginal discoloration.

Miscellaneous spots (but not on the veins) — Ammonia.

Random spots (without marginal tendencies) — Herbicide sprays, 2,4-D, pentachlorophenol, oil sprays.

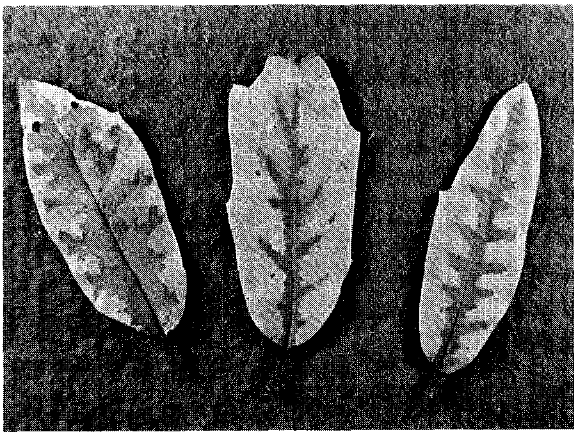

Figure 4. Copper toxicity on live oak. Orange or red-brown opaque pigment in the base and center of an otherwise green leaf.

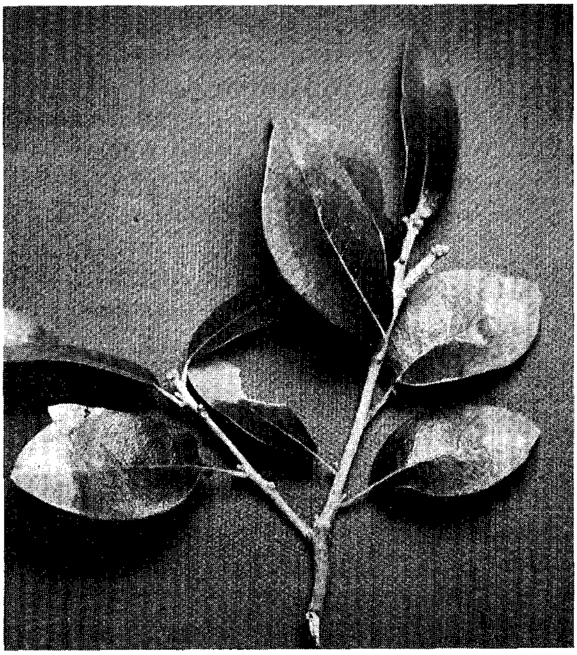

Figure 5. Oak decline symptoms on live oak. A light tan or reddish brown discoloration.

LEAVES BROWN WITH AN ABRUPT EDGE AND INTERVEINAL FINGERING INTRUDING IN FROM THE EDGE TOWARDS THE MIDRIB

Wetwood bacterial toxin (Carter, 1964 a).

Leaf Size. The oak decline wilt fungus infection causes the leaves to be smaller than they are on disease free trees. This was found by treating the trees with a systemic fungicide to kill the fungus, thereby producing larger leaves (fig. 8).

Small leaf size has also been reported for zinc deficiency (Sprague, *et al* 1964).

Thin Crown. Trees have a thin crown, excess sky and limbs can be seen through the leafy crown.

Oak decline — infected trees have small leaves. See *roots cut off*; *construction injury* below.

Roots cut off (construction injury) leaves are full sized and yellowed on systemic fungicide treated trees that have had most of the roots removed in construction.

Earth fill over roots (roots suffocation; a clumpy, thin resprout crown appears the second year after the abuse, this is after the yellowed leaves have fallen off and the smaller branches have died).

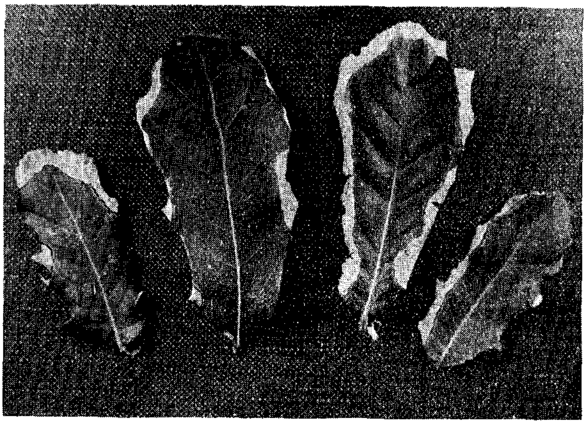

Figure 6. Chloride injury on live oak (accumulated from salt in irrigation water). A light brown to grayish discoloration.

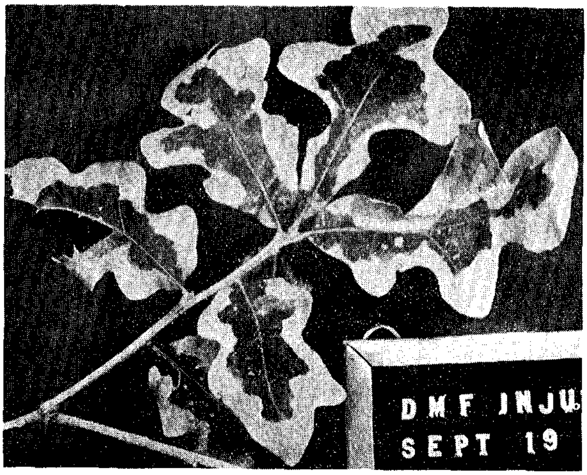

Figure 7. Dimethylformamide (DMF) injury on post oak.

DISCUSSION

The key to the leaf symptoms found on oaks can be an aid to the diagnosis of the hidden maladies encountered in the urban environment. One of the most difficult maladies to diagnose is the decline of oaks and other trees caused by the persimmon wilt fungus. Primary symptoms are a thin crown, this is followed by a fingered crown where there is resprouting from larger branches and the dead twigs have fallen off. The decline is a very slow wilt, which is most easily recognized by the dead trees that have died in concentric circles with the oldest dead trees near the center. It is the typical pattern found in oak wilt, but it progresses more slowly. The diseased trees are often those nearest to the dead trees.

Leaf symptoms are mainly the small leaf size, but the half-leaf symptom in which the outer one-half of the leaf is tan or light brown is often found in hot summer weather (fig. 5). Occasionally trees die all at once and all of the leaves hang on and turn brown. In some large areas of Texas where all of the live oak (*Quercus virginiana* Mill) and post pak (*Quercus stellata* Wangenh.), trees are infected, the only way to determine what healthy leaves look like is to inspect trees treated with systemic fungicides (Van Arsdel and Bush 1970, Van Arsdel, Lyda, and Jares 1972, Jares and Van Arsdel 1975).

SUMMARY

Leaf symptoms from part green leaves could be used as an aid to diagnosis of some maladies with

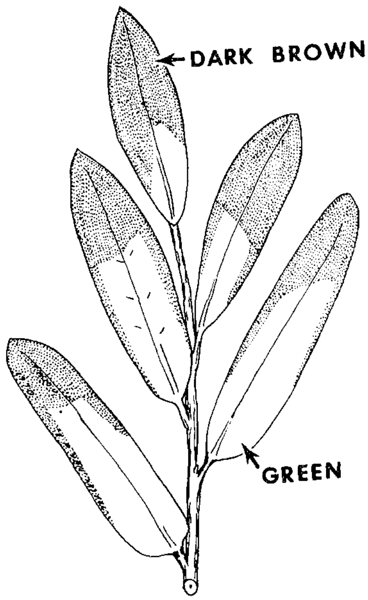

Figure 8. Excess nitrogen fertilizer.

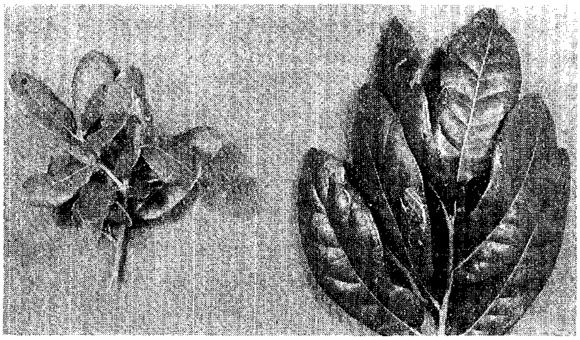

Figure 9. Small leaves from declined oak compared to healthy leaves from a treated live oak.

hidden causes that are difficult to differentiate. A descriptive partial key was presented based on leaf color, the pattern of discoloration, the character of the margin of the discoloration, leaf size, distortion or curling. It described the symptoms of root suffocation from earth fill or flooding, mineral deficiencies, herbicides, air pollutants, construction injury, excess salts, a root rot disease, and a vascular wilt disease. These symptoms provided a diagnostic aid to supplement other information such as histories and the extent of the injury.

Crown density and leaf size could also be used to help differentiate most environmental diseases from the vascular wilt fungous decline of oaks, but zinc deficiency also causes small leaves.

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