Surrounded by a blanket of hot pavement impervious to water, this tree declines more each year from heat and drouth.

Noninfectious Tree Disease, Part II

Influence of Heat and Imbalance of Water

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IN a previous paper on noninfectious diseases of trees (WTT, August 1964, pg. 10), cold injury and the mechanics of freezing of plant tissues were discussed. This paper is concerned with the influence of heat, and deficiency or excess of water.

Heat Injury

The concept of heat injury to plants is based on the ability of the temperature of plant tissue to exceed greatly that of the environment. It is most difficult and often not possible to separate the effects of heat injury *per se* from those of drying or even light. However, heat injury is most likely to occur under conditions of near or saturated humidity. Several reasons are offered to explain this. Under saturation, the plant is not only unable to lose excessive heat rapidly, but plant tissue with adequate water is more susceptible than when drier, and loss of water from plant tissues through transpiration is essentially a cooling process. In addition, because of their high water content, young, fleshy, or succulent tissues are more predisposed to increased physiological activity, and thus are more susceptible to heat damage than those which are older or hardened.

The severity of damage from heat may vary from relatively innocuous premature defoliation of leaves of deciduous trees in midsummer, to death of cambial tissues of woody stems. Heat injuries of most significance to health of trees are "sunscald" of stems on exposed sides and basal stem canker at ground line. Sunscald most often results from thawing out of the smooth bark of trees exposed to direct sunlight in late winter or early spring. As temperatures drop with nightfall, the thawed bark becomes frozen again. Alternate freezing and thawing of outer tissues in localized spots bring about differential stresses leading to rupture of tissue. Sunscald is generally restricted to trees with smooth, thin bark and occurs more often on the south or southwest sides of vertical stems. Injury is more common on trees recently or suddenly exposed following disturbance of a naturally wooded area, or removal of heavy shade from any source. When smooth, thin bark is exposed to direct sunlight and the air temperature is below freezing, the exposed tissue of the stem becomes heated above the freezing point, whereas the opposite side remains below freezing. The heat results in drying of tissue, with contraction of cells, and subsequent separation of tissues along lines of least resistance. Since the loss of water from the stem cannot be replaced, the bark tissue cracks along several vertical lines, and the affected area assumes the elongated form of an elliptical canker. Invariably these bark ruptures invite invasion by insects and microorganisms, and a genuine infectious canker may result. If no infection occurs, the stem will callus normally, and a rough textured surface may result. As with all dead tissues and potentially cankerous areas, bark so affected should be removed aseptically to prevent serious infection and stimulate clean healing. Valuable trees may be protected by wrapping or shading to avoid such damage. Particularly vulnerable to sunscald are newly exposed trees left for shade in residential areas newly developed from natural forest. Small trees with smooth bark are the most likely to be badly affected. Judicious landscape planning by a trained arborist may avoid the trouble.

Basal stem canker from heat injury is produced when the temperature at the ground line may be in excess of air temperature by 20-40° F. It is largely confined to seedlings or very small saplings that have not acquired much of an insulating layer of cork in the bark. With the air temperature at 90° F, the soil temperature may reach as much as 140° F, and the bark tissue is often literally cooked. If damage is localized on one side, the dead tissue generally becomes invaded by microorganisms. These in turn may cause genuine, infectious cankers that may or may not girdle the stem. If the bark of the stem is killed on all sides by the heat, the stem above will die eventually. Before it does, however, some changes occur providing evidence of the cause. As with all girdling of bark, if the wood remains intact, sugars elaborated in the foliage accumulate just above the girdle, which they cannot pass, and the stem may be conspicuously swollen at this point.

A mild form of heat injury occurs with excessive exudation of sugars from leaves, often depositing a white crystalline mass on leaf surfaces. Such a condition is associated with an excessive amount of water loss, as a result of high enzymatic activity within the cell sap. If the exudations are heavy and sustained, accumulation of salts on leaf surfaces may become toxic and cause the death of leaf tissues.

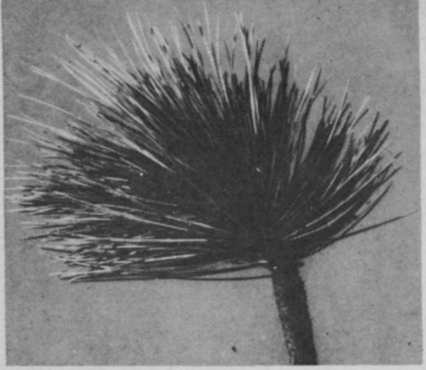
One type of heat injury associated with prolonged drouth is called "midsummer leaf drop." This is common of certain shade trees in the Midwest and else-

Salt injury to roadside Norway Spruce. Adjacent spruces are unaffected because of great distance from road and parking facility.

where. Although affected trees most often recover quickly, the sudden loss of a large proportion of the foliage may be quite a shock, especially to urban trees surrounded by unusually hot pavement. The intense heat brings about a sudden yellowing of large numbers of entire leaves, without typical interveinal or marginal burning as caused more typically by drouth alone. Associated with the yellowing and most likely the direct cause of it, is premature formation of corky abscission layers at the base of leaf petioles. Since leaf abscission is influenced by auxin formation and distribution, it is probable that the heat, accompanied by drouth, brings about a change in the auxin mechanism similar to that responsible for normal leaf fall at the end of the growing season.

With direct heat injury the tissue may be affected violently. Heat accelerates both chemical and physical reactions within cells. When the tissue appears to be destroyed by heat alone, the movement of the protoplasm within the cells may accelerate violently. With resulting chemical breakdown the structure of the cell membrane may be destroyed. Associated with the collapse of the protoplasm are the liberation of fatty chemicals and the final solidification of the bulk of the protoplasm, composed essentially of proteins.

Indirect heat injury generally occurs through loss of water by excessive physiological activity. With the onset of abnormal heat many functional processes may accelerate, and if prolonged, injury will result. The most common indirect heat injury is reported to be "shock" to the plant resulting initially in a loss of sensitivity to environmental changes. The extent of the damage may be related to duration of exposure, and if recovery is possible, the time required is directly related to time of exposure. Before serious damage occurs many changes may take place. The temperature of the plant increases excessively above that of the environment, physiological activity is increased markedly, respiration exceeds photosynthesis significantly, and growth ceases at a temperature below that which is fatal. It is difficult to explain satisfactorily the basis for indirect heat injury. It is attributed by some to starvation of the plant through excessive metabolism and by others to a chemical breakdown of proteins at heat-killing temperatures. However obscure the basic cause may be, the net effect of excessive heat on plants is, at the



Terminal "burning" of pine needles from spring drying. The change between terminal dead tissue and basal living tissue is abrupt.

very least, a weakening of tissue through changes in the functioning of vital life processes.

Water Deficiency

During the growing season the mechanics of water transport involves a constant flow of water from ground to air through the tree. Since only a small fraction of the water is consumed in growth and functioning of the plants, such a constant water requirement is considered to be a necessary evil. Plants as large as trees require so much water daily that they can grow only where water is abundant, without special structures or adaptations that minimize water loss to the air. Because of their size, trees are particularly vulnerable to water deficiency for many reasons.

Water is literally pulled through trees by cohesive forces beginning with surface evaporation at foliar surfaces exposed to air. This pull, transmitted through a long chain of cohesive water molecules from leaves to root hairs, is sufficient to remove free water from between soil particles. When the free soil water is depleted, as in a prolonged dry period, the pull still prevails and root ends, beginning with root hairs, collapse and die of desiccation. At the same time, the supply of water to leaf terminals and terminal twigs is reduced. But as the pull of surface evaporation continues, the water lost cannot be replaced, and these tissues become dehydrated.

Combined with cold injury, with which it may be associated, deficiency of water is one of the most important climatic factors causing noninfectious disease. Direct injury to plant tissue is not only related to the quantity of water lost, but to the rate of loss as well. The first evidence of water shortage in a previously healthy plant is initial wilting of terminal foliage or a general drooping of succulent tissue from loss of turgor. In mature foliage which has acquired a degree of rigidity and hardiness, first yellowing, then browning of thin tissues occurs between veins and at leaf margins. These areas at the end of the tree's waterline are the first to reflect the inavailability of an adequate water supply. If the deficiency is sustained, premature defoliation similar to that in "midsummer leaf drop" may occur. Normally confined to leaf attachments, abscission may occur at nodes of small twigs under unusual conditions. Such abscission results in dropping of small twigs, some with leaves still attached. Examination of the separated nodes indicates that the stem tissue on both sides of the nodes has contracted. The zone of separation, which occurs at the center of nodes, is characterized by the same type of corky tissue typical of normal leaf abscission and formation of leaf scars. Because the separated twigs consist of secondary tissue more than one year in age, in spite of their small size, they are structured with rays. The rays are conspicuous on the severed ends, appearing as radial ridges or cork, like spokes in a wheel.

That deficiency of water may seriously injure small, young, or succulent plants or plant parts is obvious, but what significance does it have for large trees? Unless it is prolonged, relatively little direct damage may result. However, it may weaken such trees sufficiently to predispose them to predators and weakly parasitic fungi. But water deficiency may occur in various forms. If it occurs suddenly, it is often called "scorch" and is characterized by interveinal and marginal browning of leaves. If it develops gradually over a long period of time, yellowing, browning, defoliation, and twig abscission may develop in that order. In such cases older leaves or needles are characteristically shed first.

One type of water deficiency, known as "winter drying," returns sporadically to plague us with its unpredictability of appearance. Such a phenomenon is only genuinely "winter drying" when it occurs while the ground is frozen. When air temperatures rise above freezing, and particularly when accompanied by drying wind, considerable moisture may be lost through evergreen foliage. Because the roots of such trees are icebound, the lost water cannot be replaced and the foliage dies. If drying is severe, twigs or even entire branches in addition to foliage may be killed back. Much of what passes for winter drying occurs after the ground has thawed in the spring, is really unrelated to winter or winter conditions, and occurs only because the soil is dry. Many thousands of ornamental evergreens are burned in this way each year, and much of this may be avoided by careful watering both in the fall and spring. Interestingly, in some northern states, the dieback and burning from cold injury and "spring drying" provides a needed service for unknowing homeowners. Many such owners, after paying premium prices for beautifully grown yews, do not realize that these trees must be pruned annually to maintain the same aesthetic compactness. Nature does the pruning for them, making it necessary for them to remove the brown, dead terminals with some attached live stem.

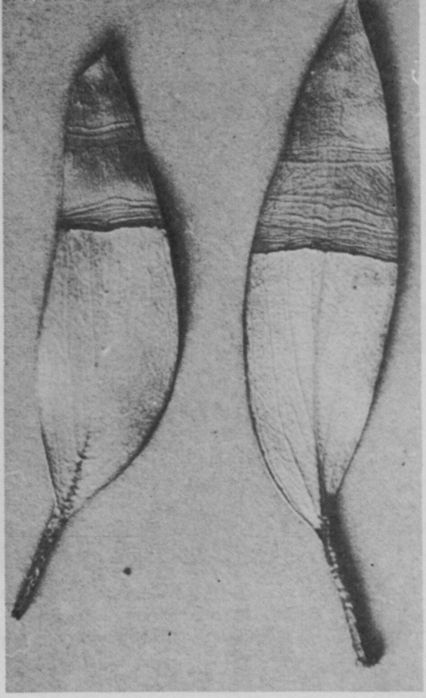
Scorching and burning of both evergreens and deciduous trees

Heat injury to fir seedlings. Stems were girdled by "cooking" heat from soil, but swelling of stems above the girdle occurred before death.

sometimes results from what is called "physiological drouth." This type of water deficiency is caused by excessive concentration of salts in soils around roots of trees affected. Water moves physically away from areas of high activity of water molecules toward areas of less activity. Normally this makes it possible for water to move into roots from the surrounding soil, where the water activity is greater. But the presence of dissolved salts decreases molecular activity of the water outside the roots, so that instead of moving into roots, water moves out of them into soil. The result is inadequate water in plant tissues, water deficiency symptoms, and drying of terminal tissues. Physiological drouth may be caused by excessive fertilization, in which case the plant is said to be "burned." Large numbers of roadside trees exposed to washings from salted highways are now believed to be affected in this way. Not only may movement of water into plants be impaired, but of more serious consequence, small roots of trees in contact with concentrated salt solutions may be killed by toxicity as well as dehydration. Later, when the salt concentrations have leached away, even if water in root zones is abundant, the tree may be unable to absorb it as quickly as it is lost through transpiration, because its absorbing mechanism has been impaired. Once weakened, it then is vulnerable to the usual disintegrating invaders, the microbes and insects.

Water Excess

Just as water must undergo a steady flow through the plant, water in the soil around plants must change constantly. Associated with water in the soil, air is no less vital to root cells. Since water and air cannot occupy the same space at the same time, roots of most trees must be alternately bathed first in one and then in the other. When water is excessive, soil air is deficient, and *vice versa*. The air is necessary because, except for certain types of aquatic plants, almost all surface root cells require atmospheric oxygen for respiration. Water-soaked roots characteristically become cyanotic from lack of oxygen and acquire a blue-black discoloration. Unable to respire, they cannot survive. Without an effective absorbing root system, trees so affected may then suffer no longer from an excess of water, but from a deficiency instead.



Dieback of terminal leaves from deficiency of water. Note the sharp delineation between living and dead foliar tissues.

Lack of adequate oxygen for tree roots is not the only adverse result of excess water. The roots may be sufficiently softened to predispose them to root-rotting fungi, and the watery environment may favor certain pathogens. But probably of greater significance, the water may bring a succession of changes in an entire new world of microbial flora and fauna. One predictable result is an accelerated increase of anaerobic bacteria, and another is the synthesis by these bacteria of chemicals toxic to plant roots. Some authorities believe that such toxins may be of greater significance than the asphyxiation of roots through absence of oxygen.

Excess water around roots is directly related to drainage; and drainage is largely a function of soil texture and structure. Excessive fractions of clay in soils result in poor drainage, and excess of water here is the rule. Perhaps the most serious type of soil condition leading to excessive water around roots is a clay hardpan within a few feet of the soil surface. When extreme, such a hardpan may be impervious to water. Even if not impervious, drainage may be so slow as to be insignificant. If undetected when small trees are planted, a hardpan may become a problem only when the trees are large enough for their roots to be affected. Trees so placed have a limited depth for root development, and tend to develop shallow root systems near the soil surface. Because of this, in time of drouth such trees may be badly deficient of water. With heavy rains, their roots become soaked, eventually to die. Often this is the type of site the new homeowner meets when he plants his first shade trees. If the soil does not consist of a hard base beneath the topsoil scraped off initially, it becomes thoroughly compacted in real estate developments; and if it has even a moderate clay fraction, it may approach a similar condition. When a thin layer of topsoil is added for lawn culture, the hidden tree trap is complete. Under these conditions only penetration of the clay by drilling will provide a permanent solution to avoid potential root damage by flooding.

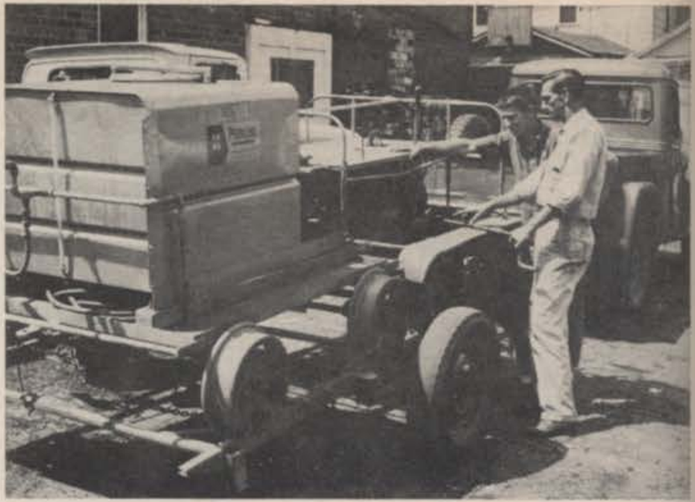
In Summation

Although different factors of the natural environment are now recognized as primary causes of tree disease, the complexity of the interaction from them is but little understood. To attempt to understand how each one operates, we try to isolate them as separate, independent variables. But none of them operates by itself; each one influences and is influenced by the others. To further complicate the picture, each of them predisposes trees affected to a variety of infectious diseases, which, although secondary, may be none the less serious, often obscuring the primary cause of noninfectious origin. It is also significant that environmental conditions determine the conditions that make infectious disease possible, because infectious causes do not operate in a vacuum either. And finally, as man changes the natural environment and creates a synthetic one, in spite of his efforts to duplicate nature, he lacks the knowledge necessary. In the process of change and in the attempt to restore, he creates a wide variety of new conditions, whose impact on the physiology of trees, and thus on their pathology, we can foresee but dimly. It is certain that this area of pathology needs and will get more attention but only through basic research.

The author is indebted to Dr. G. R. Cooper of the Dept. of Botany and Plant Pathology of the Univ. of Maine for photography.

Azo CHEMICAL

Versatile Contract Applicator



Easily towed, the small motorized handcar with sprayer-trailer has increased Azo's business capability. Here, Earl Baer, 7-yr. Azo veteran (right), shows Dave Norman how a Studebaker transmission helps treat railroad yards.

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TO THE UNINITIATED, Azo's railroad "track treater" at work seems like a fantastic game of tag between a huge locomotive switcher and the tiny motorized handcar with its sprayer-trailer attached.

First the switch engine moves down the track pushing several idle boxcars out of the way. Then the little handcar comes putting along behind, its pump and boom spraying weeds in the ballast. When the handcar eases to a stop behind the switcher, the game reverses. The handcar runs and the leviathan locomotive slowly pursues it back to the starting point.

When the pair comes to a switch, a controller in the tower throws a lever and the incongruous duo repeats its game on a new set of tracks.

To Lawrence A. Smith, president of The Azo Chemical Co. of Canton, Ohio, treating 15 miles of railroad yard track is industrial weed control "business as usual."

The day's work done, the handcar putts to a crossover grade, and is winched onto a balanced two-wheel trailer and handily hauled back to the Canton offices.

The motor car was a wise purchase Smith made several years ago, when customer demand for weed control in railroad yards warranted the investment. Although the car was useful for treating yard track, Smith found that the drive mechanism—four speeds forward and a friction wheel drive reverse — was not suited to the requirement for both forward and reverse speeds. After burning out several friction wheels in reverse, Smith removed the factory-installed transmission and put in his own Studebaker transmission — less second and high gears. He used only low and reverse so his own men would be relieved of the temptation to hot rod on the railroad tracks. With a reverse gear instead of a friction wheel, his need for reverse speed equal to forward speed was filled.

The Azo Chemical Co. is an 18-year-old business which began in Canton in 1946 as a pest control firm. Four years later, in 1950, pest control customers began demanding weed control service. Smith read up on the subject and

Fence-line brush control is part of Azo's industrial service. Here, Jim Whitmer, a "key carry-over" man, applies systemic brushkiller and Telvar (monuron) soil sterilant for quick topkill and lasting residual control.

discovered he was already equipped with machines to do successful weed control work.

For the past five years Azo has been headquartered in a large, "vintage" warehouse at 715 9th Street NE in Canton. In spite of an out-of-the-way location in the 32,000-sq.-ft. building, Azo has grown from $30,000 a year gross in both pest control and weed control 10 years ago, to a present $125,000 total yearly volume in both fields.

Smith credits approximately $50,000 worth of business to pest control. Of the remaining $75,000, 90% comes from statewide industrial vegetation contracts, and the rest from local residential lawn jobs.

Growth Began With Weed Control

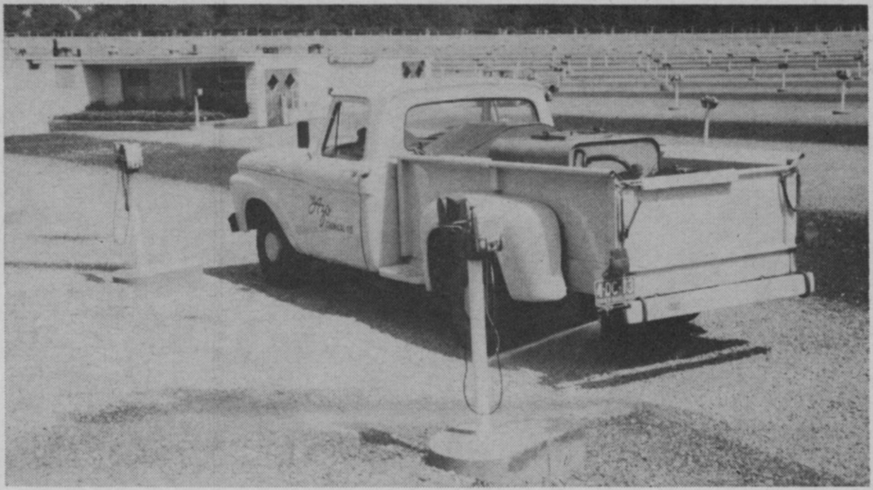
"We started to grow when we began to offer weed control," Smith says. "For the first couple of years we were hesitant about what to use, so we experimented a lot to find out what was best for us. There was no good standard source of regular information at that time."

Smith has high regard for Telvar, DuPont's monuron soil sterilant, and brushkiller (2,4-D and 2,4,5-T mixtures). Lately, he's found increased success with the new Hyvar X water-soluble bromacil sterilant. Usually only one soil-sterilant treatment is necessary, but an Azo agreement provides for at least two inspections during the summer to make certain there is no regrowth or no missed spots.

"Over the years our truck fleet has grown to 12 vehicles, three of these for pest control in the summer and nine for weed control. In winter, two trucks are turned over to pest control," Smith explains.

"When our weed control trucks are out of service in the winter, we put them into mothballs, so to speak," he adds. "They get a good cleaning, and a fresh paint job; then we cover the mothballed trucks with 6-mil polyethylene tarps which are sealed with tape. This keeps them fresh and clean for spring. We also cancel insurance on trucks not used in winter."

Azo paints the trucks various pastel shades of blue, pink, and green to demonstrate dramatically the size of his fleet.



Off-center nozzle mounted in this truck's rear bumper treats speaker posts at drive-in theaters. The driver of this ¾-ton Ford controls spray from inside cab. Telvar is the herbicide used here.

"We're presently using ¾-ton Ford and Chevrolet pickups for normal weed control operations. We also have two Jeeps to use where trucks might have trouble or around homes where a small vehicle is an advantage," Smith points out.

Chain Hoist Good Investment

When Azo moved into the present headquarters, the company had 13 trucks, each equipped with an application rig. This was a carryover burden for the winter slack period. "It was then that we saw the possibility of using a chain hoist in this building. We mounted an I beam through the garage to the door. I bought a heavy chain hoist in a junk yard for five cents a pound and mounted it in the shop," Smith recalls.

"With this hoist we were able to eliminate one truck and double our number of sprayer units to 26," he goes on. "Now one truck can do any of seven weed control or pest control jobs with only five minutes changeover time."

An Azo truck can carry a 100-gallon spray rig for an industrial soil-sterilant job, or, with a simple change of units, the truck can perform residential lawn weed work with a 25-gal. sprayer. With a simple turn of four nuts, the rigs are bolted firmly onto a truck bed.

Smith keeps his tank and pump rigs mounted on skids, which can be set onto dollies and wheeled to any place in the shop for repair or storage.

"When we overwinter spray rigs, we store them in a pigeonhole affair constructed of 2x4 lumber. We can stack the spray rigs three high. This innovation was necessary because we didn't have room to store both our trucks and sprayers on the floor, so we had to put them up in tiers. It's a great help to us," Smith affirms.

Azo has 15 employees; 13 of

(Continued on page 22)

Edging with chemicals keeps grass from growing between posts of parking lot barrier. Ken Barnhart applies soil sterilant with low-pressure gun. Note plasticized chemical-resistant gloves, worn to protect the hands.

St. augustinegrass lawns are particularly susceptible to chinch bugs as evidenced here by light spots among the healthier, dark parts of the lawn.

How to Diagnose Turfgrass Problems, Part II

THIS concludes a two-part article, begun last month, on methods of detecting turfgrass ills. Author White bases his recommendations on his experiences in Florida, but the techniques he discusses are useful for turf technicians all across the country. Last month he talked about general diagnosis principles and miscellaneous symptoms. Ed.

By RALPH W. WHITE, JR.
General Manager
Ousley Sod Company
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Soils Problems

Soil compaction. Soils often become hard or compacted where traffic is concentrated in certain areas and when they are saturated with water. Compaction causes a shallow root system, poor drainage, puddles and weak grass. During hot, dry weather, these areas may wilt because of the shallow root system. During periods of rainfall or watering, the soil may remain soggy and puddle because of poor drainage. During these periods, scum or algae are often present. Grass in compacted areas is often sparse with many of the stems dead.

Layering. Layering results from improperly mixing soil amendments or top dressing lawns with different types of soil, such as sand, muck, and marl. Because of the different water-holding capacity of the various soil layers, root growth is limited usually to just the top layer.

Buried debris. Often debris, such as pieces of building blocks, lumber, and cement shingles, are buried during construction. Many of these materials, being alkaline, lead to an iron deficiency causing the green to turn yellow. Wilting, too, often occurs because the soil usually dries out rapidly in these spots.

Soil variation. Dry spots, soggy soil, compaction, and differences in growth or color of the turf may be due to variations in soil texture. This condition results when topsoil, fill, or amendments are added to certain lawn areas or the materials are not thoroughly incorporated with the native soil.

Nutritional Symptoms

Nitrogen. Nitrogen retention in most Florida soils is very limited. For this reason, nitrogen usually is the first nutrient to become deficient. The older leaves begin turning yellow at the tip and along the leaf margins, and continue until the leaves are entirely yellow and the tips begin dying. The general effect on the entire lawn is a light-green color.

Phosphorus. If the lawn has not received a complete fertilizer for some time, and the leaves and stems develop a reddish-purple color followed by dying of the leaves and a thinning of the turf, there is a possibility of phosphorus deficiency. It should be mentioned, however, that phosphorus deficiency is difficult to diagnose.

Potassium. A shortage of potassium is indicated when leaves

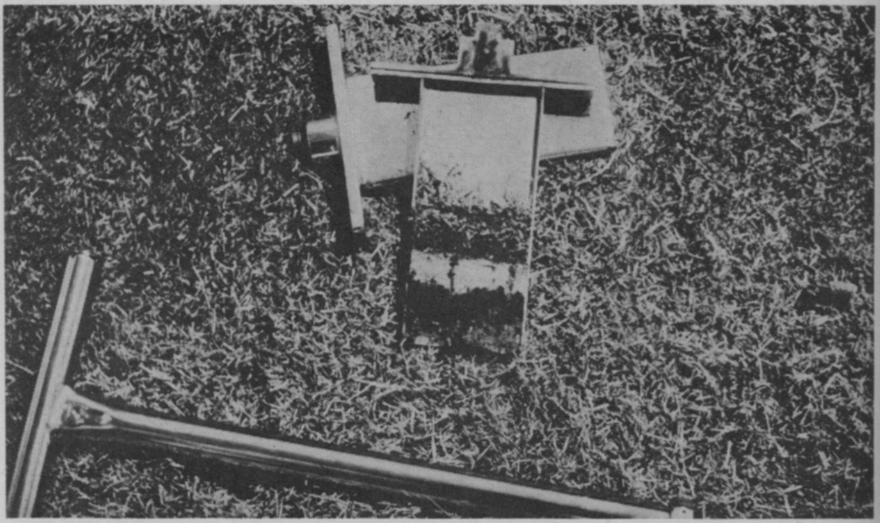
Weed-free turf

Dacthal effectively kills weeds and undesirable grasses in the ground before they sprout. Won't damage ornamentals and shrubs. Best weed control yet for golf-course and fairways, parks, rights-of-way, etc. Keep your turf weed-free with Dacthal applied professionally for best results. Diamond Chemicals, Diamond Alkali Company, 300 Union Commerce Building, Cleveland, Ohio 44115.

Diamond Chemicals

become yellowish with tiny reddish-purple spots similar to gray leafspot on st. augustinegrass, but smaller.

Iron. Iron deficiency usually shows up in distinct areas of the lawn. The new leaves become yellowish while the larger veins in the leaves remain green. Iron deficiencies can result from an alkaline soil situation, a poor or stunted root system, or can be induced by overstimulating the grass with fertilizer when iron is limited in the soil.



Layering, or irregular stratification of soil surface, can be seen by inserting wedge as above. Different layers have different water-holding capacities, which adversely affects root growth.

Insect Symptoms

Chinch bugs. Infestation usually begins in the sunny areas of the lawn near a sidewalk, drive, or house. The grass begins to turn yellowish and then brown in patches. As the population increases, the areas begin to spread and can kill an entire lawn. Each patch has a characteristic dead or brown center with a yellowish margin.

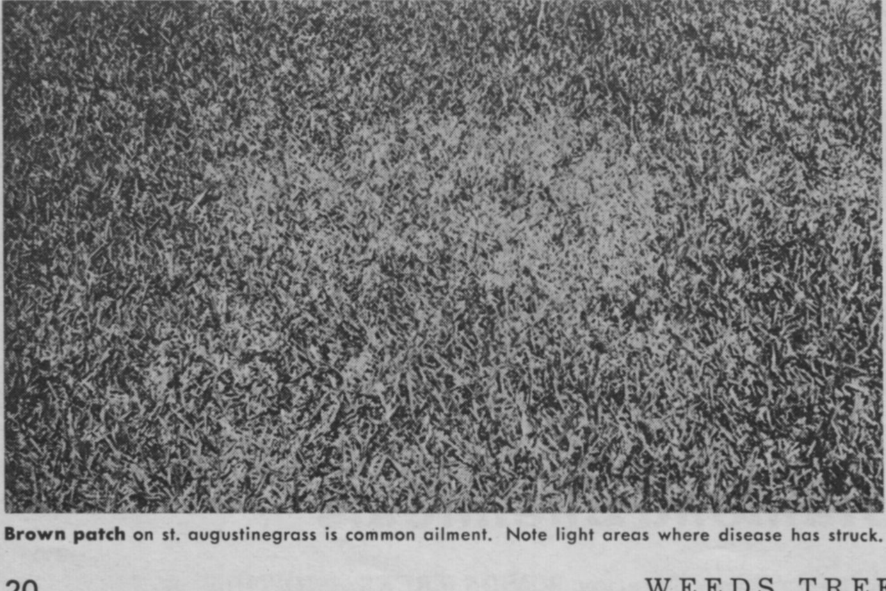
Sod webworms. Damage begins in small patches and, in many cases, in the shady areas around the house. When the population first begins, close inspection of the grass blades reveals the leaves to be chewed along the edges. As this damage continues, the leaves may be completely stripped. In zoysia and bermudagrass, early stages of sod webworm damage are often confused with dollarspot fungus, since little brown areas are formed. Positive identification can be made by parting the grass and looking for small worms in a curled position, or for little green pellets of excrement.

Armyworms. Damage is the same as the tropical sod webworm, but often spreads much faster and usually does not form definite patches.

Rhodesgrass scale. This scale usually causes a slow decline and a thinning of the turf. Infestations often begin in shaded areas. This white, cottony scale attaches itself to the joints of the grass, sucking out the plant juices.

Mole-crickets. These are usually most severe on zoysia and bermudagrass; however, they are destructive on other grasses, especially new plantings. They loosen the soil by forming small tunnels, and cut the roots, thus causing the grass to wilt easily.

Billbugs. These pests are most destructive to zoysiagrass but can also damage other lawn grasses. The first symptoms are small, yellowish, dead areas. The affected grass can be pulled out of the ground with the roots attached. As the damage progresses, the area becomes larger. Localized dry spots are also symptoms. The damage is caused by the young or grub.



Brown patch on st. augustinegrass is common ailment. Note light areas where disease has struck.

Grubs. Feeding on the grass roots, grubs cause yellowish and brownish areas to develop in the turf. The grub is much larger than the billbug larvae.

Wireworms. Wireworms tunnel into stems of the grass and cause yellow-brown spots and wilting. The symptoms often look like brown patch fungus. Wireworms seem more prevalent on centipedegrass.

Bermudagrass mites. Damage to bermudagrass displays a rosette or "witches broom" effect, caused by a shortening of the internodes. Usually these infested areas begin to thin out, and the grass slowly declines. The mite is microscopic, wormlike in shape, with a whitish-cream color. The mites are found under the leaf sheaths and vary in number from a few to hundreds.

Disease, Nematode Symptoms

Brown patch. The grass is affected in circular patches, which may vary in size from a few inches to several feet. The disease is more prevalent during late fall through early spring. However, it can occur at other