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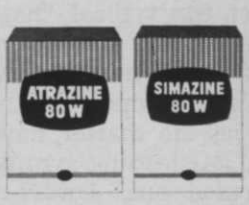

How to Diagnose
Shade Tree Root Diseases

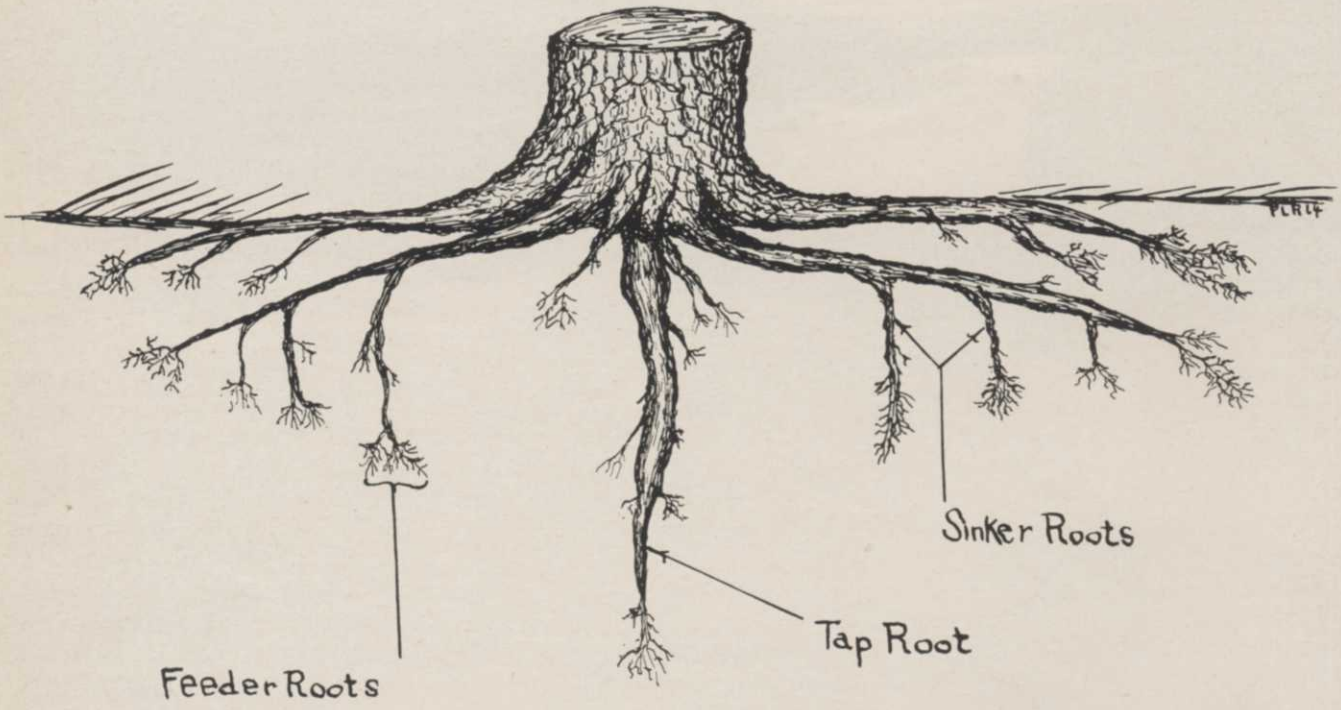

Diagram of typical pine roots. Much remains to be learned about diagnosing root diseases, author Rusden says, so tree specialists must exercise diligence in using all available data to help spot the trouble.

By DR. PHILIP L. RUSDEN
Chief Pathologist
Bartlett Tree Research Laboratories
Stamford, Connecticut

DIAGNOSIS of tree diseases affecting the visible, above-ground parts of a shade tree is not easy. But it is a "pushover" compared with diagnosis of root troubles. A good diagnostician must know the normal tree and its requirements. He must identify the species correctly, recognize the growth zone to which it is adapted, evaluate the form, foliage density, size, and color. He should look for "normalcy" clues in the growth rate of twigs.

Quite a list of questions must be answered satisfactorily with regard to soil, site, exposure, drainage, temperature ranges, insolation, and general ecology of the typical "happy" tree. A probable condition of disease will be indicated when one or more signs point to abnormalities, no matter how slight.

Misleading symptoms must be ruled out. Dwarf varieties are not necessarily "sick." They are just small because of genetic factors. Variegated forms of ash or maple, for example, should not be suspected of pathological chlorosis. Some trees come into leaf late and/or shed foliage early because of genetic aberrations. Observations made in a single season may not reveal the basis for this kind of odd behavior.

Above-ground symptoms of trouble may be secondary. Primary causes may well be subterranean—out of sight. Out of mind, too, for the investigator who is untrained or simply drowsy!

When we would like, literally, to get to the root of the matter we may be stymied. The soil-penetrating, root-revealing X-ray machine has yet to be invented. In ignorance of what may lie below the soil, there is a temptation to speculate as to possibilities. Rachel Carson doled out *possibilities* with a free pen. Scientists, on the other hand, deal with *probabilities* based upon recurrence of carefully observed phenomena. It is *possible* that the tree on a dry site is drowning from a water pocket at its roots. It is *probable*, however, that it is suffering from drought since thousands of trees on really dry sites have been seen to be prime sufferers from drought.

Root Knowledge Scant

What do we know about the normal root system of a mature tree? Even professional botanists do not pretend to identify woody

plants from root specimens. In most instances, it is just too much of a chore to examine root systems through layers of mud, silt, clay, loam, gravel, and rocks. Many professional tree men spend their whole lives without ever having dissected out the entire root system of one mature tree. Our knowledge of roots, their functions and their ailments, is based on hundreds of bits and pieces of information acquired through the years. It is small wonder that our knowledge of the normal root system is sketchy. It follows that our store of root-disease know-how is relatively scanty. On the other hand, we do have a vast storehouse of knowledge of the complex soil fauna and flora, the thousands of microscopic and macroscopic animals and plants that spend their lives in the soil in intimate association with tree roots.

Roots grow in soil. Soil consists variously of inorganic and organic particles of all shapes and sizes from iron oxide molecules to boulders, intermingled with water, air, and odds and ends of gases. In general, tree roots do well in good soil and not so well in poor soil. This is not the place to discuss the chemico-physical qualities of soils in detail. Suffice it to say that faulty soils are the basis for many root diseases. Indeed, diseases in the form of physiological imbalance are much more common than infectious diseases due to specific organisms. Very small changes in temperature or moisture in roots can lead to trouble. The greater the relative change, the more obvious the source of such trouble becomes.

Tree roots must have *enough* soil in which to grow by normal cell proliferation. The root system of a tree is roughly proportional to the crown or system of branches. Confine the roots and you automatically reduce the size of the crown. A layer of clay hardpan or a rock ledge just below the upper soil "horizon" can have this root-reducing confining effect.

It's hard enough, author Rusden says, to diagnose tree diseases affecting the above-ground portions of a tree; but root diseases are even more perplexing. In this article, Bartlett's expert pathologist offers for treemen everywhere some inside tips on root care.

Roots of most trees need a granular soil in which the particles are relatively small. And a high proportion of the soil components must be nutritious — must consist of water-soluble minerals to yield the N, P, K, S, Cu, Fe, Mo, C, and other elements that are sent up in the sap stream to the photosynthesis factories in the foliage.

Insufficient or improper chemicals in the soil may cause the death of some roots. Water is needed to dissolve the chemicals if they are to be taken up by roots. Lack of water, i.e., drought, kills by desiccation. Excess water kills by drowning, a form of asphyxiation.

Dead Roots Invite Attack

Once dead, a group of roots are subject to attack by saprophytic bacteria and fungi. Some of these, once they are established, may become active parasites and go on to kill more roots. Large roots and even the trunk of the tree are attacked. The entire tree may be nearly dead before signs of trouble are visible in the crown.

Infection courts are often the result of mechanical damage. Windstorms can sway the crown enough to break roots. Excessive cultivation of flower beds near trees can break roots. Heavy machinery passing over the soil in which roots are growing not only compacts the soil unduly but actually fractures many roots. Digging away of soil in highway and building construction exposes thousands of roots to desiccation and infection. Bacteria and fungi are always

Bacterial crown galls, like the one shown here on the root of a willow tree, are typical results of the diseases Dr. Rusden discusses in this article.

This wood-rotting fungus, *Polyporus frondosus,* is one of many ailments tree service personnel must guard against. This growth is fruiting at the base of a large pin oak tree.

Nematodes, known scourges of lawns, also attack trees. The nodules shown here on roots of an oak tree are nematode-induced.

present in the soil ready to avail themselves of any breaks in the protective cortex of the roots. Once started, root rot is likely to continue.

Poisonous chemicals introduced into the soil are oftentimes directly harmful. Road salt (Na Cl or Ca Cl_2) may accumulate where drainage is poor. Roots are killed even though very slowly in most cases. Chemical waste from factories, natural or manufactured gas from leaking mains, and methane from rotting vegetation can kill roots.

Trees planted too far north (or south) of the zone to which the species is adapted will die. Trees improperly planted will often develop girdling roots that will strangle other roots and even cut off sap movement in the trunk. Planted too deep, roots will smother; too shallow, roots will freeze in winter or bake to death in summer.

Root Enemies Abound

A growing tree root not only meets mechanical and chemical barriers. It meets active enemies in the form of chewing rodents, digging dogs, grubbing humans, boring insects, cell-penetrating nematodes, noxious bacteria, rotting fungi, and occasional higher plant parasites such as *Monotropa*. Viruses, such as the

(Continued on page 32)

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UNION CARBIDE **AGRICULTURAL CHEMICALS**

Turfgrass Portraits VIII:

Centipedegrass

By DR. ROBERT W. SCHERY

Director, The Lawn Institute

Marysville, Ohio

This is the eighth in a series of nine articles on the basic traits and maintenance procedures for common turfgrasses. Next month author Schery discusses st. augustinegrass.

OF THE TURFGRASSES in our "Portrait" series, centipedegrass or "Chinese lawngrass," *Eremochloa ophiuroides,* is perhaps the most enigmatic. It has many qualities of a world beater, then erratically goes to pot because of seeming trifles (viz. minor fertility imbalances). It's not a demanding grass; indeed, it resents fertilization that strongly forces growth. Where adapted, centipede has few equals for easy-to-get-along-with lawns, which is doubtless why another of its popular names is "lazy-man's-grass."

Eremochloa ophiuroides is a Far Eastern species introduced from China by the USDA in 1916 (some references) or 1919 (other citations, including the Agricultural Yearbook, *Grass*). There are no recognized varieties, although a hardy selection is reported ready from Oklahoma. Strains are distinguished by stem color, with some authorities suggesting superiority of a red-stemmed introduction (PI 72260), and others (University of Florida) seeming to prefer green-stemmed types.

Eremochloa is a small genus of the bluestem *(Andropogon)* tribe. It consists of a handful of species native to southeastern Asia and the East Indies. The majority are passably fine-leaved, and further search might uncover breeding stock worthy of introduction.

Adaptation and Appearance

Centipedegrass is at its best on the Coastal Plain from North Carolina south through southern Georgia, and northern Florida west into Mississippi. It has had limited success west of the Mississippi River (possibly because of increasing soil alkalinity in more arid regions), and is scarcely consequential in Arizona and southern California. A more usable western centipede might come from the pending Oklahoma release. Although centipede survives north into Tennessee, it is discolored by frost rather readily, and is seldom so useful as bermuda and zoysia in the upper South.

Much of the region where centipede is heavily used has sandy soil. Yet centipede grows on clays, too, although it prefers well-drained to waterlogged locations. A major weakness is yellowing (chlorosis) for lack of available iron, a condition often triggered by soil alkalinity. So centipede has gained a reputation for being adapted only to acid soils. Yet it flourishes without special precautions on some alkaline soils of south Florida; there's probably a lot more to it than mere tieing-up of soluble iron at a pH above 7. Probably a complicated interaction of nutrients and trace elements determines centipede's peculiar sensitivity to iron (with growth stimulated by N in spring, or K in summer, it seems unable to pick up sufficient iron, especially if P is high!).

There is no question that centipede is one of the better southern grasses where low fertility prevails. In the give-and-take of ecological progression, centipede then has the advantage. With no help other than mowing, it can aggressively spread through and eventually dominate a turf (this is one reason for keeping centipede away from pastures, where it is a poor yielder of nonnutritious forage). Though centipede responds well initially to high fertility, it often turns up its heels the next year. And it is probably not quite so good a shade grass as are St. Augustine, bahia, and zoysia, though far better than bermuda. In southern Georgia centipede delights in the open shade of pines.

As its poor reputation for forage might suggest, centipede is low growing, seldom over a few inches high even when unmowed. This can be quite an advantage for lawns only sporadically tended. Mowing need not be frequent (each 10-20 days), although with any lawn weekly mowing keeps things tidier. Mowing is not difficult, even with light equipment, which is quite a contrast with zoysia. Moreover, centipede is hardly injured by scalping, often a problem with rampantly growing species that produce abundant top growth. Centipede is usually mowed about 1½ inches tall. Seedheads are relatively low and inconspicuous, certainly not the problem we have noted with certain bermudas and bahia.

Centipede spreads by thickish, trailing stems (stolons) that stay flat against the ground. Fortunately, they have fairly short internodes and thus a dense presentation of leaves. The stolons, of course, root at the joints. The leaf blades are of medium width, finer than St. Augustine, but coarser than the better bermudas and zoysias or the famed bluegrasses or fine fescues. Speaking of bluegrasses and fescues, one is reminded that centipede grows so dense that winterseeding with these excellent wintergrasses is more difficult in centipede than in bermuda.

Performance and Care

Outstanding is centipede's ability to develop slowly into an aggressive, relatively weedfree turf, with very little attention. Yet being strictly stoloniferous, it is not hard to control at borders. In contrast with bermuda, edging once per year usu-

ally suffices. Centipede does not recover so quickly as does bermuda, nor does it wear so well as tough zoysia. Thus it is seldom recommended for heavily trafficked swards such as play fields.

The quality of centipede turf is not up to that of finer textured bermudas and zoysias. It is used chiefly where this is less important than ease of maintenance. We have remarked on centipede's adaptability to acid soils (so that liming is seldom called for), and its low fertility requirements (a single feeding in the spring often suffices). However, authorities usually recommend at least two yearly feedings, at about 1 lb. actual nitrogen each time, ordinarily employing a complete fertilizer.

Iron chlorosis can be corrected in some soils by adjusting the pH to mild acidity, as with sulphur-containing products (for alkaline soils), or perhaps by liming very acid ones. Up to 10 lbs./M of iron sulphate should give relief, and iron sulphate sprays cause immediate greening. An iron chelate such as DTPA at 1 lb./M may have a more prolonged influence than iron sulphate.

Except for the sucking, scale-like "ground pearl," centipede is relatively free of insect pests. Chinch bugs, the scourge of St. Augustine, hardly bother it. Ground pearls dwarf the roots, debilitating the grass. No practical control has yet been found, and where ground pearls are very serious, probably the easiest course is to switch to another grass. Nematodes may cause similar debilitation, though the turf should then respond to nematocides. Nor are diseases very serious on centipede. Brown patch can be checked with general fungicides, such as Thiram and mercurials.

Weed control is much the same as with St. Augustine, except that centipede is tolerant of 2,4-D. In the early stages of lawn formation, centipede may profit from preemergence crabgrass preventers (for sprigged or plugged lawns, not seeded ones), or simazine and atrazine. Don't use arsenates. Fortunately, centipede eventually forms so thick a sod that it fights many of its own weed battles. Perennial centipede will ordinarily crowd annual crabgrass into submission the second year.

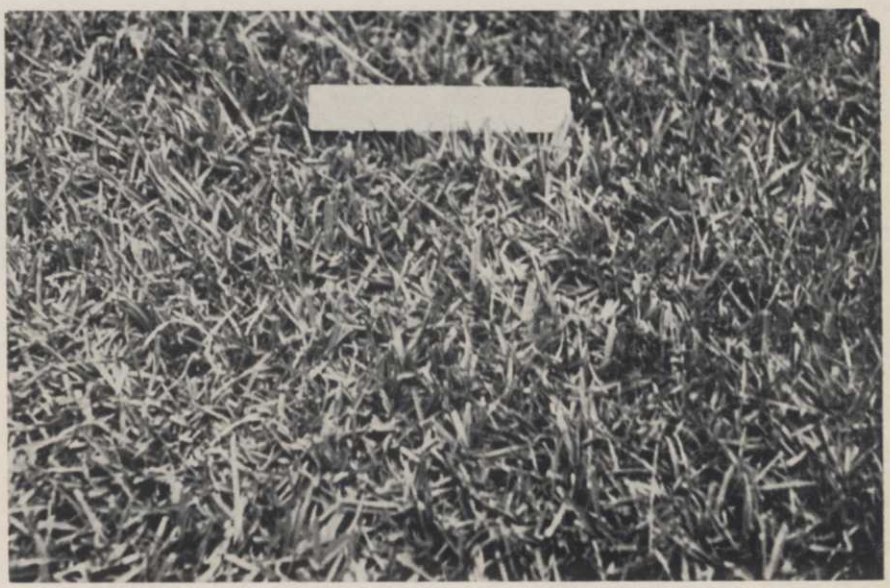
Centipede endures drought reasonably well. Though turning completely brown, it recovers quickly with rain. But to be consistently attractive, lawns require occasional irrigation in dry weather. This is especially important on the prevailing sandy soils of centipede country, which hold so small a moisture reserve. Centipede is not tolerant of salt sprays, so is not for seaside plantings.

Propagation

Centipede has long been propagated vegetatively by sprigs or plugs. A cultivated and fertilized seedbed may be planted in rows about a foot apart, with individual starts 6″-12″ apart in a row, sprigs buried 1″-2″ deep at one end but most green leafage left above ground. Or live starts can be introduced into an old lawn, to infiltrate and eventually take over. Of course, the prepared seedbed offers a much better opportunity for quick and thorough establishment.

For some years centipede seed has been available in limited supply. Maintaining centipede stands just for seed, plus difficulty in harvesting the low, infrequent seedheads, makes seed understandably costly (quotes run up to $15 per pound). But there are nearly ½ million seeds to the pound. One might prefer sowing a pound or so/M, but cost dictates lighter sowing, only a couple of ounces (extended with inert) per M. Even very light sowings eventually dominate, although sprouting may be slow and seedling expansion deliberate. Seeding is best in spring, raked lightly into a prepared seedbed, watered consistently for several weeks. There are excellent centipede turfs in parts of Florida where the owners don't remember ever having started the grass, so seed must be effective in spreading the grass.

All in all, centipede is a distinctive grass, of great usefulness for lightly maintained turfs of the southern Coastal Plain. By and large it is of "intermediate" nature, being neither fine textured nor coarse, not without troubles but neither prone to disaster. It is also middle-of-the-road in cold hardiness, drought resistance, shade tolerance, and in most other respects. With time centipede makes a tight, weed-repressing sod that is easily tended.



Closeup of a healthy stand of centipedegrass shows typical characteristics that make it a "middle-of-the-road" species, such as its texture which is neither fine nor coarse.

√☒ New Ways to Appl

INCREASING water consumption, engendered by the population and industrial growth of the United States, has presented water managers with many problems in obtaining a product of the highest purity.

Not the least of these is the constant battle against microscopic organisms manifested in the various forms of algae, whose presence can give water a distinctively unpleasant fishy taste and odor. While taste and odor are not of prime importance to industry, pumps, boiler tubes, filters, etc., can be clogged by algae, leading to expensive shutdown of equipment. In the manufacture of inks, dyes, paper, and in photographic processing, the presence of algae can cause an end product not up to acceptable industry standards. And many contract applicators wage constant war on algae in private lakes, ponds, marinas, etc.

The use of copper sulfate as an algicide is standard practice. However the method of applying the chemical is varied and reflects local conditions and requirements.

While the dragging of a burlap sack filled with copper sulfate crystals behind a rowboat is still being used, labor costs have dictated more efficient procedures.

The Phelps Dodge Refining Corporation Information Service, as part of its program of providing data pertinent to water

A 100-lb. bag of large copper sulfate crystals is fed into bronze-screen hopper by this workman for the Seattle Water Department. Two-point pivot mounting allows hopper to ride up should it strike underwater objects or shallows.

treatment, has been in contact with water management personnel throughout the U.S. regarding the types of application equipment employed. Some of these methods will be of interest to those charged with algae control.

WTT readers may obtain detailed drawings and specifications of the equipment described in this survey through the Information Service, 300 Park Avenue, New York 22, N. Y.

Blower System

One method, for example, is used on occasions where it is desirable to *blow* a chemical dust rather than use a slurry or solution. The Helix Irrigation District of La Mesa, California, uses such a system.

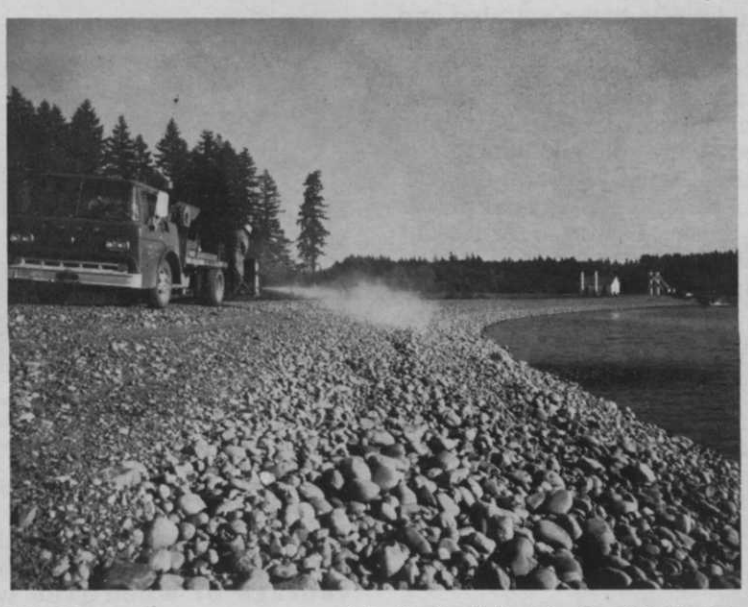
The principal advantage of the blower-type machine is the ability to treat large surface areas rapidly with a light dosing of material. Another advantage is the breaking down of crystals in the blower to a fine dust.

The blower operates from 3,000 to 3,500 rpm, which has the tendency to grind the commercial-grade $CuSO_4$ snow into smaller particles. These small particles are blown into the air, and wind currents assist in spreading them over the surface of the water.

Certain disadvantages are found in the blower-type machines. For example, the larger machines are heavy enough to reduce the permissive load of chemical in the boat; and two or more men are required to transport the units in and out of the watercraft. The machines also need continual adjustment by a trained operator, such as a contract applicator, to maintain a constant feed and to obtain an even distribution of copper. An excessive rate of feed may clog the discharge spout. Use of these blower-type machines is dependent upon the wind for distribution of chemical, and with shifting winds the boat crew as well as the reservoir may be dusted with the material. There is always the loss of varying amounts of copper sulfate dust that is carried away by the wind and then settles upon the above-water shoreline of the reservoir.

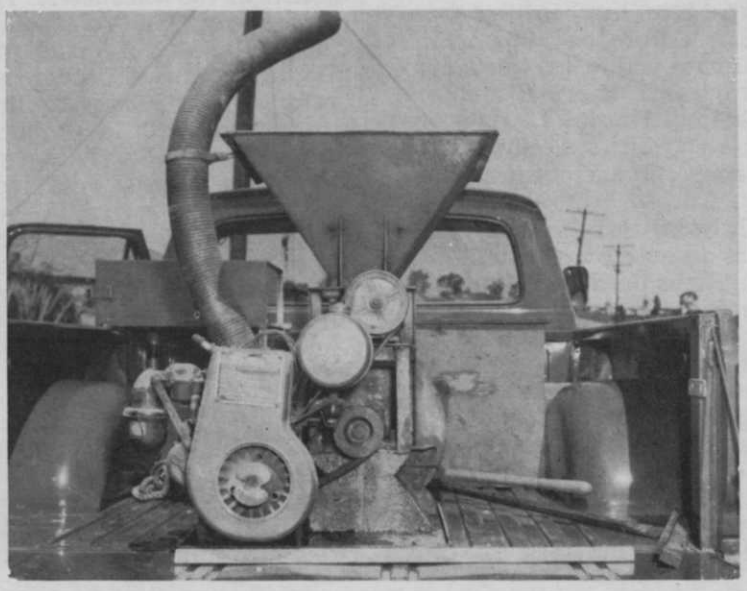
The calm, nearly perfect day is far from ideal for this type of water treatment. It means a much lighter feed of copper sulfate and much closer treatment lanes which require a considerably longer time to cover the given area. Optimum weather conditions consist of light winds of 10 to 15 mph blowing steadily from one direction. This permits a higher rate of copper sulfate feed, and a marked increase in the width of the treatment lanes, thus decreasing the total time of treatment considerably. An area of 1,804 acres can be treated under favorable conditions in 4½ to 5 hours with 5 tons of the algicide. On a calm day, treatment would require from 10 to 12 hours for completion. Reservoir treatments should be com-

(Continued on page 24)



This blower dispenses copper sulfate for the Helix Irrigation District of La Mesa, California.

Blowers for dispersing aquatic herbicides and algicides can also be mounted on trucks, as is this machine used for treating the Seattle Water Department Reservoirs.



(from page 10)

cide for the commercial applicator in industrial weed control," Hallett said.

Dacogen, a fourth product, but still in the premarket experimental stage, is a phenoxy herbicide formulation with a physical spray drift inhibitor. It bowed to the NCWCC with the help of technical man, R. L. Schauer, Diamond Alkali Co., Cleveland, Ohio.

"This material is added in powder form to water in a spray tank. The powder will contain concentrations of 2,4-D, or 2,4,5-T, or both. Dacogen acts as a liquid while being agitated and sprayed. But after contact with a plant surface for a few moments, it reverts to a gel state," Schauer explained. This phenomenon may be likened to the solidification of a gelatin dessert.

"Once applied, Dacogen is sticky," the Diamond rep went on; "it adheres to plants, keeping the herbicide in contact with plant tissue longer. This happens because the gel hardens and encapsulates the herbicidal material beneath the shell. Upon complete drying, the Dacogen formulation produces a film, still attached to the plant where it was sprayed. The material also inhibits volatility," Schauer said.

Aquatic Talks Well Attended

As the section symposiums got underway on the second day, *WTT* reporters found topics of interest being aired in the well-attended Aquatic Weed Control session.

"Aquathol and Hydrothol are two aquatic herbicides from Pennsalt Chemical Co., which have found value in weed control programs where fish safety is a factor," Harold Lindaberry, Northern Technical Supervisor for Pennsalt's agricultural division in Aurora, Ill., said.

Both compounds have endothall as an active ingredient, but formulations produce differences in herbicidal activity. Lindaberry explained that Aquathol is an effective herbicide for many submersed weed species at 1 part per million, a rate far below that where fish will be harmed. He related that Pennsalt experienced no mortalities when Aquathol was fed to laboratory dogs at 800 ppm daily.

"Hydrothol is formulated with the amine salt derived from coconut oil," Lindaberry went on. This changes the activity so that the compound is effective at concentrations of 1/10 to 4/10 ppm. Hydrothol is correspondingly more toxic to fish, however.

No Aquatic Cure-alls

An underlying theme of the conference emerged during the open discussion of the aquatic session. It is that there are no cure-all chemicals. Chemicals are tools designed to do specific jobs and should be planned or programmed for this purpose.

Session moderator, John Gallagher, Amchem Products Co., Ambler, Pa., drove a point home when delegates debated the advantage of weed-free water. Completely weedless water may not be the desired end. When conservation interests are involved, as they are with increasing frequency, it may be desirable to induce new plants to establish in the vacancies. This is particularly true on wildfowl refuges. Instead of letting nature take her course, a farsighted operator will disperse millet or smartweed seed to produce an improved habitat with waterfowl food plants designed for best possible use of the water body. The aquatic weed controller must be an ecologist, able to make best possible use of available water, not simply one who chemically removes weeds from water.

Industry and education find common ground at breaks between scheduled sessions. Pennsalt's Harold Lindaberry (left) hears Ohio State horticulture professor Dr. E. K. Alban's views on ornamental crop weed control.

Crabgrass Trials Failed

1964 was a strange year for crabgrass. It did not germinate on schedule, and in many places not at all, to any significant degree. This put researchers testing preemergence herbicides in the awkward position of not having any test plants.

Dr. Robert W. Miller, professor of agronomy, Ohio State University, Columbus, revealed that crabgrass failed to establish because of dry weather. A second germination period did occur, but if turf was not irrigated, this weed crop failed, too.

"These conditions force us to take another look at preemergence herbicides," Dr. Miller asserted. "During years when unseasonably dry weather occurs, it will be necessary to apply preemergence materials which last throughout the season."

As an alternative, Dr. Miller offered split applications of herbicides that are not active season-long.

"We do have a good selection of preemergence crabgrass controllers, but there is room for improvements," Dr. Miller feels.

Improvements he would like to see include: good long-season control; herbicides specific for annual grasses; materials which will permit perennial lawngrass seeding the same spring as preemergence treatments; material which does not damage turfgrass; more latitude on date of application; and preemergence material for crabgrass and annual bluegrass in bentgrass turf.

How Santa Fe Kills Weeds

"There are numerous reasons why weeds along railroad lines must be controlled," Dave Yazell, Vegetation Control Engineer for the Santa Fe System, Albuquerque, N. M., began in his talk at the session on industrial weed control, during which he explained the Santa Fe's maintenance methods.

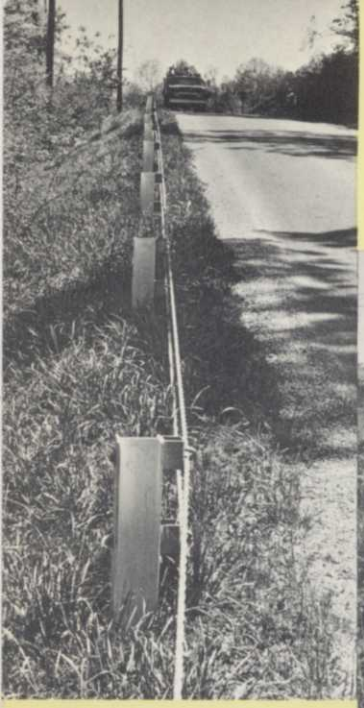
Older methods of burning and on-track and off-track mowing are being replaced by chemical treatments. Yazell listed four kinds of treatments his railroad uses. Bare-ground control requires sterilant chemicals and is initially high in cost. Annual maintenance costs are of course reduced. Santa Fe uses what it calls abatement control; this offers a high degree of general weed control, but no bare-ground results. Chemical mowing with materials such as pentachlorophenol or sodium chlorate retards plant growth.

Under selective chemical control, Santa Fe eliminates noxious

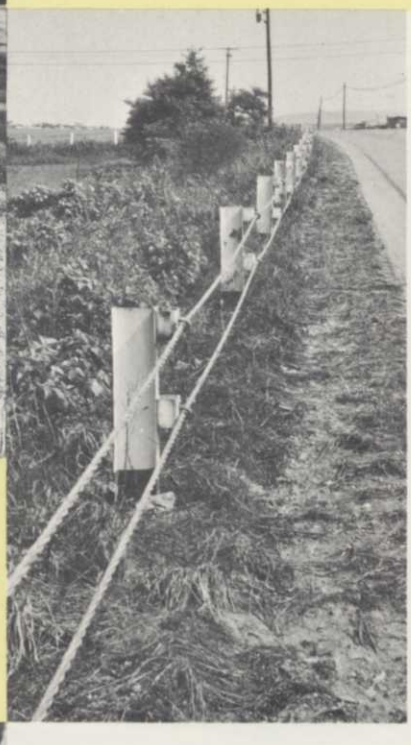
(Continued on page 21)

Industrial Weed-Brush Control *made to order to keep grounds more attractive and reduce costs by saving on hand labor.*

A good maintenance-management program around industrial plants is now considered just as important as attractive furniture and clean surroundings inside. Good "housekeeping" can be an important factor in employee and community public relations. Buildings, no matter how well-planned, can look unattractive if surrounding areas are not kept clean and weed-free. This is why more and more *(continued on back page)*



▲ *Highway guard rail before spraying with Amizine herbicide.*



One week after application, weeds and grasses were white or brown. In three weeks vegetation was dead. Amizine provides full season or longer control. ▶

▲ *Amchem's skill and research provide continuous improvements in weed and brush killers that provide better control for your weed control dollar.*

AMCHEM HAS THE RIGHT WEED-BRUSH KILLER FOR EVERY PURPOSE:

There are more than 60 high quality Amchem weed and brush killers to answer the most difficult vegetation control problems. Every one of these herbicides or compounds has been carefully formulated and thoroughly tested at Amchem's research farm as well as on research and experiment stations throughout the nation. Every product is tailored to give you the most complete, economical control feasible under your own conditions. One or more of these herbicides or combination products is just right for **your** vegetation control problems.

Amchem research has pioneered more developments in weed and brush control than any other company. Amchem originated 2,4-D, 2,4,5-T and Aminotriazole weed killers. Then they introduced a whole new concept of selective weed and brush control to assure continuous improvements in material as well as special application methods. Amchem combines their technical skill, research, production know-how and field services to give you herbicides with a "performance difference." The Amchem difference can make a big difference in your labor efficiency and help cut your costs.

SPECIALIZED WEED KILLERS

AMIZOL®
Provides outstanding top kill and moves throughout weeds' system to kill roots. Controls most annual broadleaf weeds and grasses. Effective on poison ivy, poison oak and many other woody plants.

AMIZINE™
One application gives dependable kill of existing weeds and grasses and prevents regrowth from germinating weed seeds for a full season or longer.

FENATROL®
Very effective in lower rainfall areas. Kills growing weeds and prevents new weed growth. Controls puncture vine, Russian thistle and kochia.

AMITROL-T
Knocks out hard to kill deep-rooted perennial weeds like Canada thistle, quackgrass, poison ivy and many others.

FENAC®
A single treatment controls problem weeds like kochia, Russian thistle, puncture vine, knapweed, bindweed and seedling weeds and grasses.

SPECIALIZED BRUSH KILLERS

WEEDONE®
Formulations: WEEDONE BRUSH KILLER 64; WEEDONE INDUSTRIAL BRUSH KILLER and WEEDONE 2,4,5-T. Superior formulations for outstanding control of hard-to-kill woody plant species.

DINOXOL® AND TRINOXOL®
Formulations: DINOXOL 64, DINOXOL, TRINOXOL. Special concentrated herbicides for control of woody plants.

WEEDAR® AMINE BRUSH KILLER AND WEEDAR 2,4,5-T
Spreader-sticker added for more effective wetting. Use in place of ester brush killers when high temperatures are common, or volatility is a factor.

ENVERT
Formulations: ENVERT DT; ENVERT T. Thick, viscuous water-in-oil formulas for aerial application by helicopter for special brush problems (root suckering species), high brush or in areas relatively inaccessible.

EMULSAMINE® BRUSH KILLER AND EMULSAMINE 2,4,5-T
Special formulas developed to use where maximum safety from volatility is required in areas of high temperature.

HOW YOU CAN CUT COSTS ON ALL THESE INDUSTRIAL USES WITH AN AMCHEM HERBICIDE PROGRAM

Roadside Maintenance

More efficient and economical use of men and equipment is an important reason why highway engineers and contract applicators are using an Amchem highway vegetation control program. AMIZINE and FENATROL herbicides can reduce maintenance costs and increase beauty because just one application kills growing vegetation and prevents regrowth from germinating weed seeds for a full season or longer. The proper use of these special Amchem products can just about eliminate mowing and hand clipping along roadsides, under guard rails, around sign posts, trees, fences and bridge abutments.

Utility Rights-of-Way

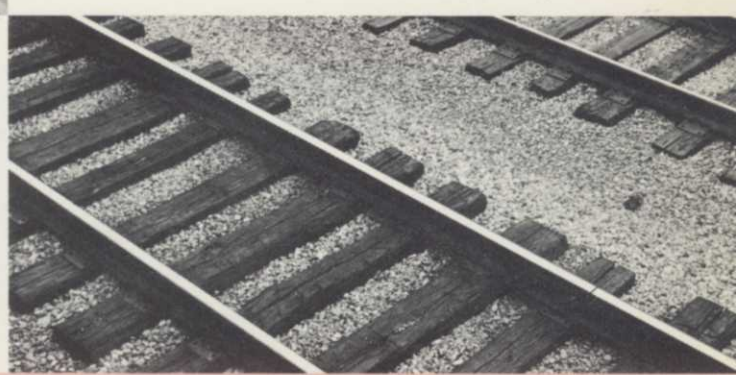
How to keep labor and expenses low when controlling mixed brush in rough or inaccessible terrain on rights-of-way where brush is too tall to spray with ground equipment has been answered with Amchem's aerial application programs. Amchem's thick ENVERTS (water-in-oil emulsion formulas) are formulated for precision application and effective control with minimum drift when applied through Amchem's patented SPRA-DISK applicator mounted on a helicopter. Many contractors are experienced in the use of these formulas and application methods. Amchem has a full line of specialty brush killers including those for ground application to answer the most difficult brush and weed control problems.

Industrial Grounds Maintenance

Grounds maintenance supervisors and contractors want maximum beauty at minimum cost. Amchem's specialty herbicides keep costs down by saving on hand and machine labor. For example, hand clipping and maintenance can almost be eliminated around buildings, trees, ornamental plantings, storage areas, and on stone walks, parking lots and fencelines with just one application of AMIZINE herbicide. This product provides fast, dependable kill of growing vegetation and prevents new weeds from sprouting for a full season or longer. It's safe when used as directed, nonflammable, odorless, does not stain concrete or metal—won't corrode sprayers or tanks.

Railroad Vegetation Control

Cost-conscious railroads have been successful in lowering the cost per mile, per day of effective weed and brush control. Amchem's special herbicide programs help cut maintenance costs more effectively. Each different area of the country requires a specific program tailored to solve its own vegetation problem most economically. These programs for track and yards are developed by areas for each railroad. Program recommendations are based on results from large areas treated with the best herbicides or combinations applied by Amchem's specially designed spray car. There is a full line of Amchem foliage (stem) sprays for mixed brush and trees on rights-of-way, and other specialty chemicals for brush control.



WHY AMCHEM HERBICIDES CAN SAVE YOU MONEY

Amchem specializes in the weed and brush control field. Amchem herbicides are formulated from the finest raws and consist of chemicals refined to a far higher degree of purity than ordinarily found. This invisible margin of product purity results in the maximum obtainable effectiveness for each formulation—a margin of performance that often pays off visibly.

Many Amchem herbicides are effective on a wider range of weeds and brush—they control the hard-to-kill species. Amchem has designed selective chemicals and combinations for maximum control in different areas of the country. They have introduced and encouraged new labor and cost saving application methods. When you add up all these benefits, you save money because you get the most efficient results.

(continued from front page)

maintenance supervisors or maintenance contractors are using an Amchem vegetation control program to provide maximum beauty at minimum cost.

Although maintenance costs continue to go up, many companies are able to "hold the line" or even reduce costs by saving on hand and machine labor. This is possible, for example, because special Amchem combination herbicides like AMIZINE or FENATROL make possible practical short cuts that can now save important time and dollars.

It's possible to eliminate hand clipping around buildings, trees, ornamental plantings, storage areas, and on stone walks, parking lots and fencelines with just one application of AMIZINE. The almost endless—and costly—job of hand trimming grasses and tough weeds is not necessary. AMIZINE or FENATROL provide positive top kill of growing vegetation and prevent regrowth of germinating weed and grass seeds in the soil for a full season or longer. They kill a larger variety of weeds and grasses including deep-rooted perennials.

AMIZINE and FENATROL are easy to apply in any standard sprayer—won't corrode equipment. They are non-flammable, odorless and won't stain steel, concrete, etc. You can save money on profit-robbing maintenance costs—lower the cost per day of effective weed control on a full season basis—with these amazing products.

FENATROL is recommended for areas where there are no desirable shrubs or trees nearby. It contains a powerful combination of three weed killers that affect both growing and germinating weeds. It is extremely effective where puncture vine, Russian thistle and kochia are problems, and in low rainfall areas. AMIZINE is ideal in normal rainfall areas. It contains a highly effective balanced combination of fast-acting post-emergence weed killer and a long-lasting pre-emergence weed preventer.

There are a full line of Amchem selective weed killers for turf areas and brush killers for control of mixed brush and trees to save labor and cut costs.

AMIZINE Mixing Directions
(Dry Powder)

AMIZINE	WATER	AREA
1 cup	2 gallons	500 sq. ft. (10′ x 50′)
1 pound	5 gallons	2,000 sq. ft. (40′ x 50′)
5 pounds	25 gallons	10,000 sq. ft. (100′ x 100′)
20 pounds	100 gallons	1 acre

FENATROL Mixing Directions
(Liquid Concentrate)

Apply 9 gallons of FENATROL liquid per acre in at least 100 gallons of water per acre. For smaller areas, use 2 gallons of FENATROL in at least 20 gallons of water per 10,000 square feet. In low rainfall areas, apply 4½ gallons of FENATROL in 100 gallons of water.

Write for FREE brochure with full instructions on Amchem's industrial weed and brush killers.

APPLICATION METHODS WITH AMCHEM BRUSH CONTROL HERBICIDES

1. FOLIAGE APPLICATION
This method requires complete wetting of all foliage and stems while vegetation is actively growing. The carrier is water or an oil-water carrier can be used. Herbicides used: **Weedone Brush Killer 64, Weedone Industrial Brush Killer, Weedone 2,4,5-T, Weedar Amine Brush Killer, Weedar 2,4,5-T, Emulsamine Brush Killer, Emulsamine 2,4,5-T.**

2. MODIFIED BASAL APPLICATION
This technique is for oil-water emulsion spray. Drench base of plants. Then wet remaining stems and leaves to run-off, spraying the lower 4/5 of the plant from bottom up. Treat when brush is in full foliage. Herbicide used: **Weedone Brush Killer 977.**

3. DORMANT CANE BROADCAST SPRAYING
Use this method in the fall after plants are dormant. Spray the base of the stems sufficiently for good run-down to root collar zone and broadcast spray to wet all aerial portions. Spray all ground to control small root suckers. Oil is the carrier. Herbicides used: **Dinoxol 64, Dinoxol, Trinoxol.**

4. BASAL BARK APPLICATION
This method employs oil as the carrier. The spray solution is directed at the base of all stems until spray puddles on all sides and collects around root collar at ground line. Apply any time of year. Herbicides used: **Dinoxol 64, Dinoxol, Trinoxol.**

5. STUMP APPLICATION
Spray solution at base of all stems until spray puddles on all sides and collects around the root collar at ground line. Carrier is oil. Spray at any time of the year. Herbicides used: **Dinoxol 64, Dinoxol, Trinoxol.**

6. AERIAL APPLICATION
Amchem's Spra-Disk® applicator mounted on a helicopter using Envert formulas gives outstanding control on rights-of-way where brush is too tall to spray with ground equipment or in rough, inaccessible terrain. Precision, low drift safety. Herbicides used: **Envert DT, Envert T.**

AMCHEM PRODUCTS, INC. AMCHEM® AMBLER, PENNSYLVANIA

First name in herbicide research

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Form No