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your water into the more acceptable 4-6 pH range. Consult your pesticide dealer for a compatible adjuvant for this purpose.

Fungicides containing copper would not have the water adjust for pH. The acidity may cause enough copper to solubilize that it will cause plant injury. Sprays containing lime should not be acidified for obvious reasons.

Disposal of Pesticide Containers.

EPA regulations call for no pesticide related materials to be disposed of by open dumping, open burning (except small quantities of combustible containers not in excess of 50 pounds, or those emptied in a single work day — whichever is less and which did not originally contain organic forms of mercury, lead, cadmium, arsenic, beryllium or selenium), or water dumping.

However, it is interesting that the EPA would state in its publication that "Since adequate disposal sites and the necessary facilities are not readily available nationwide, and since significant information gaps exist which make it infeasible to write specific criteria for certain disposal methods; and procedures, prescriptive regulations requiring specific methods of disposal should not be insured at this time. The Agency has, however, elected to issue prohibitionary regulations to limit and constrain the worst acts listed above."

WTT

Helicopter spraying

by Charles H. Tadge, Mayfield Country Club, South Euclid, Ohio

We've been using an aerial program at Mayfield, primarily for fungicide application, for the past eight years.

Shortly after moving to Mayfield in 1967 it became evident to me that a regular, preventative fungicide program was necessary since our turf was a combination of bentgrass and *Poa annua*, the greater portion being poa.

Mayfield was built on very rugged terrain. There are numerous steep slopes on the fairways. This makes pulling tractor drawn spray rigs very difficult. In those early years we were cursed — we're always cursed with poorly drained heavy clay soils — but in those early years we seemed to be cursed with perpetual wet weather. This really made spraying and even mowing difficult to accomplish without damaging the turf surface.

Our three primary fungal problems were and continue to be Helminthesporium leaf spot, dollarspot, and snow mold.

We tried substituting a boomjet spray rig for our regular boom rig. This gave us better coverage and consequently fewer passes on the fairway and fewer tracks, but still it was more susceptible to wind drift and not quite as exact, and it still didn't completely eliminate the problem of traversing the hills and subsequent marking of the surface.

In 1969, we became aware of a helicopter spraying service that was available in northern Ohio. Several courses were using their services and opinions were varied but mostly favorable.

During the winter of 1969-70, we found that snow mold incidence on our fairways was quite severe, despite treatment the previous fall. On the first of March snow coverage melted, but the snow mold fungi were still active. With more cold weather and snow very probable, it was imperative that we treat the fairways. Ground conditions were such that we couldn't drive on the course with anything so arrangements were made for the helicopter to come in and spray our fairways. This was done on March 3, 1970.

We were so impressed with the apparent coverage and speed of completion that we decided to try a complete program in 1970. That year they charged us $160 per application and we furnished the chemicals. As might be expected, next year the price rose to $240 per spray. Due to both price increase and the unavailability of the helicopter on a few occasions when we needed it, we only used the spray two times in 1971.

After carefully analyzing the relative cost, we felt we could still justify aerial spraying and we went back to a complete program in 1972. We have continued the service on a regular basis since 1972 with an average of about eight sprays per year.

We don't rely 100 percent on the aerial spray program. Like any course we've got perennial trouble spots where disease, particularly dollar spot, seems to persist, so periodically we'll touch up these areas as needed with our boom spray.

We're presently the only course in northern Ohio that's using an aerial spray program on a regular basis. Several courses have used the service occasionally for spraying fungicides. Two courses have been sprayed for grubs and report good control. They have also sprayed one course for broadleaf weeds on fairways with good success. Usually once a summer we've had Mayfield sprayed for control of mosquitos.

Continues on page 25

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Helicopter
from page 22

Probably the greatest single factor in the success of an aerial application is the effective performance of the pilot. We've been fortunate to have the same pilot over the past several years. He learned to fly in the service, had quite a bit of experience in Vietnam, and is very capable and conscientious. Last winter he became the owner of the company.

Actual spraying time involved at Mayfield has been about an hour, with an equal amount of time needed for filling and mixing chemicals. The helicopter is calibrated for an application of five gallons per acre at 35 miles per hour. Effective swath is 40 feet. Droplet size is very fine. Proper droplet size is very important to take advantage of the rotor wake and also to minimize drift.

Naturally, wind is a very significant factor. We try to spray when the wind is five miles per hour or less.

The helicopter is like a giant airblast machine. Several million cubic feet of air are moved rearward and downward during flight. When flown at heights of less than 10 feet, the rotor wake effectively drives the material into the foliage. Swath width increases as height above the ground increases, but drift potential also increases.

There are curls formed at the ends of the rotor wake called vortices that disappear last into the foliage, presenting a reliable, visible indication of swath width at air speeds of less than 35 miles per hour.

The helicopter's maneuverability and agility to work in close spaces is a paramount asset. We found that pocketed greens may get too much material if the helicopter backs into the pocket and then sprays out from a standstill position. This can be eliminated by coming in over the trees and suddenly dropping down to the surface to be sprayed. You have to have a good pilot for this. Some pilots don't want to use this technique.

The cost for spraying is presently $300 per application. An analysis has shown that spraying with our equipment would cost between $170 and $200 per application. This includes wages, payroll taxes, gasoline, equipment maintenance, and depreciation. This still falls short of the $300 price we pay for aerial spraying, but there are other factors to consider. It frees a key employee and tractor to perform other tasks. No ruts, soil compaction, or tire spins ever occur, no matter how wet the soil surface may be. When adverse weather threatens and fungal diseases are active or imminent, the spraying can be accomplished very quickly.

The prime question which must be asked is how much is it worth to have all the fairways and greens sprayed in one hour with no tractor sprayer interfering with the golfers or other maintenance operations. We feel these factors justify the added cost for aerial spray.

Another factor that might be worth considering for some courses would be the use of EPA restricted chemicals. If the course personnel were not certified to apply these chemicals, the helicopter service could be contracted to perform the function. All hazards inherent with the handling of the materials could be born by the aerial spraying applicator.

In conclusion, aerial spraying by helicopter may not be the ultimate answer. It may not fill everyone's needs, but at Mayfield we are well satisfied with the results we have experienced. WTT

THE SCIENCE OF SOILS FROM NEW TURF HANDBOOK

William H. Daniel, Ph.D., Department of Agronomy, Purdue University, W. Lafayette, Ind.

Soils are composed of particles of an infinite variety of sizes and shapes. The soil profile, as described and classified by state and national surveys, is the result of gradual changes that have occurred during soil formation. More than 7,000 natural soil types have been identified and classified in the USA. Indiana has 36 groups of soils which include more than 700 types. A soil is typed according to its texture — sand, silt, clay. Soil types also reflect the parent material, drainage, climate, and vegetative growth associated with the soil during its formation.

Organic matter, the residue of plant decay, creates specific characteristics in the soil profile. The tall grasses of the prairies helped to create the deep black topsoils. The northern pine forests on the sandy soils in Michigan helped to create a leached organic upper and a dense lower soil horizon. Soils under hardwood forests are medium dark because they contain medium amounts of humus. Soils developed under low rainfall and high temperatures have little organic matter.

Dr. Daniel is in the final stages of writing his new "Handbook for Turf Managers." The book has 39 chapters on topics such as Management, Grasses, Rootzones, Pest Control, and Turf Uses. The new book will be available from Harvest Publishing Co. this spring.

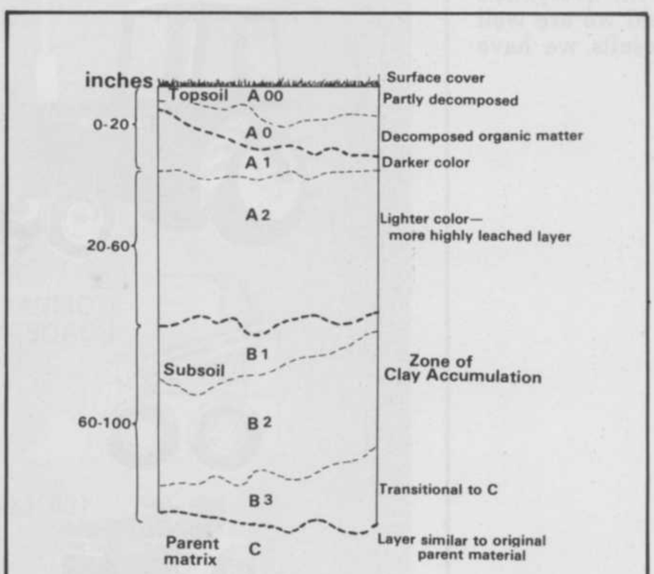

Figure 1: Drawing of a typical soil profile.

A. Source Of Parent Material

An infinite variety of physical and chemical forces have combined to create the different soils. Some of these forces are volcanic eruptions, freeze and thaw, mountain stream erosion and flash floods. Those big rough boulders of the mountain streams eventually become the gravel of the river, the sand of the shoreline, the silt and clay of the flood plain and the clay of the delta and the ocean floor. The process of erosion, grinding, wearing and sorting helps to produce many soil types.

Freezing and thawing as a weathering process is powerful. As water freezes it expands 9% or 1/11th of its volume. Every chip, crack or crevice becomes a pressure point. As the rock flakes, its surface is exposed to the weather's attack on its solidarity. Weathering is a process affecting all particles, tending to continuously subdivide them. This earth's covering is thin because weathering is primarily a surface phenomena.

The natural processes of soil formation are continuously at work. When soil particles are moved by water, gravel and sand particles settle quickly but move as the currents change. Clay settles slowly, and as a result, moves into deeper water where dense layers are formed. Periodically, a flood of incoming water contributes silt and sand to the clay layers. Eventually, the water level changes, the lakes dry up, the poorly drained flat plain is left with productive clay or clay loam soils.

In portions of Canada and central United States the glaciers of the ice age moved the material that other forces had assembled. Boulders were transported hundreds of miles, topsoil was stripped to bedrock (some areas in Canada), lakes were gorged (Finger Lakes of New York), old river valleys were buried (Teas River of Indiana), and new rivers formed (Ohio River). As the glaciers melted, their terminal moraines became gravel and sand deposits. Undulating as well as level land was left stony, or, in some cases, remarkably free of stones. Large gravel and sand deposits were created by the sweeping power of outwashes.

Winds play a continuing part in soil deposition or structure. The huge loess deposits downwind (east) of the Mississippi River, the sand ridges along creeks and lakes, and the sorting process across the deserts all illustrate the force of the wind.

Vegetation tends to stabilize soil surfaces as well as to produce organic matter for a multitude

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of organisms. As these organisms feed and die they effectively contribute to the granulating and structure creating processes of soils. The decay of plant parts accompanying the release and recycling of elements used in plant growth are fascinating conservation phenomena.

Chemicals and clays carried into the oceans gradually become sedimentary layers of limestone, sandstone, shale and other rocks. When lifted by geological forces, such as earthquakes, the new land exposed joins in this cycle of constant change.

Chemical processes, such as oxidation, solution, hydration, and carbonization, are constant acting factors making soil formation a continuous process. The result is the textured and structured soil that anchors the plant and serves as a reservoir of nutrients, water and air.

The different layers or *horizons* constitute the soil *profile*. The "A" layer of the profile is the zone of organic accumulation, the darker colored, structured topsoil. The second layer or "B" horizon, is made of clays and other fine particles collected as fragipans, or dense clay layers and subsoils. The "C" horizon is the parent material, which has been less affected by weather, water and organic matter interactions.

Many soils of western North America tend to be less developed since they have received limited water action in the recent geologic past.

B. Soil Texture

The sizes and shapes of soil particles determine the soil texture. The infinite variety of sizes are classified as colloids, clay, silt, sand, gravel and stone. Clay, silt and sand contribute most to soil-plant relationships.

B-1. Soil Texture Classification

Soil separate	Diameter	Particles/gm	Surface area in 1 g.
	mm	number	sq. cm.
stone	over 25	-	-
coarse gravel	25-5	1	-
fine gravel	5-2	30	-
very coarse sand	2-1	90	11
coarse sand	1.0-0.5	720	23
medium sand	0.5-0.25	5,700	45
fine sand	.25-.1	46,000	91
very fine sand	.10-.05	722,000	227
silt	.05-.002	5,776,000	454
clay	below .002	90,260,853,000	8,000,000

The intermix of particles has been classified into soil types based on the predominance of the fractions involved. (See Fig. 2). Sandy clay loam soil has only 20% clay but it is identified as such because clay particles characteristically standout. A soil must have more than 50% sand before it can exhibit the characteristics of a sandy soil. Silt particles act individually unless captured as organic aggregates or fragipans.

Cracking and fracturing of the soil is minimized when the clay content is less than 30% and is diluted with sand and silt.

C. Soil Structure

Soil structure is determined by the arrangement of soil particles within aggregates, granules and clods. Cations, colloids and humus contribute to their formation and stability.

Most clays have a net negative charge which allows the particles to join with positively charged ions such as calcium (+2). Bacteria and fungi produce secretions and decaying plants release compounds which cement particles together.

D. Topsoil

A medium sandy loam topsoil containing sufficient organic matter (5-10% by volume or 2-3% by dry weight) should be well granulated. The degree of granulation is expressed as the percent of the silt and clay content occurring as aggregates. A soil with 60% aggregates is considered to have good structure.

Aggregates of soils created by binding agents, colloids, cations, humic acids, and decaying organic matter are more stable to the forces of water. In comparison, aggregates formed by physical forces such as wetting and drying, freezing and thawing, and /or tillage operations are relative unstable.

In general, topsoils which drain well enough to allow air into at least 25% of the pore space (or 10% of volume) within twelve hours of saturation are considered satisfactory for most uses.

E. Topsoil Standard

The British (B.S. 3882:1965 of British Standards Institution) have identified topsoil into categories:

Topsoil is the existing surface layer of grassland or cultivated land. It is usually a darker shade of brown to black because of its organic matter content mixed with the mineral matter. Topsoil tends to be friable and show some degree of poros-

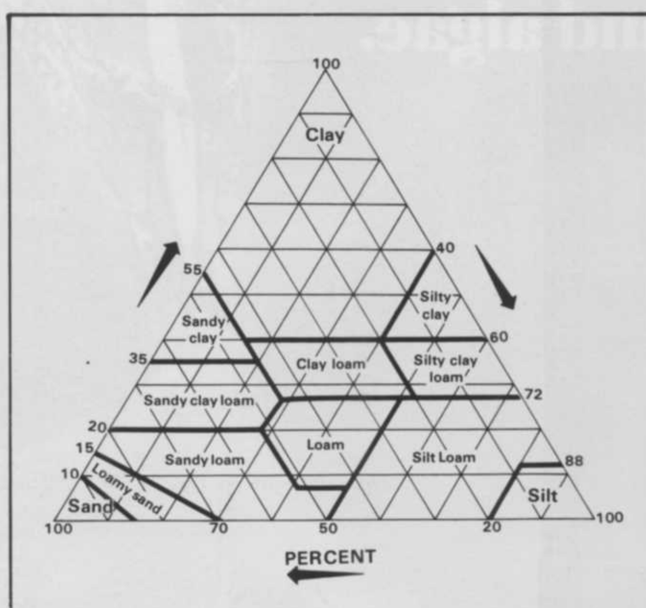
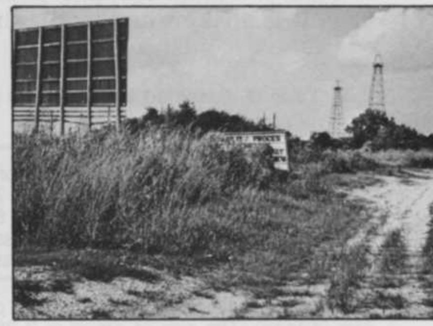


Figure 2: Textural triangle showing the various soil types.


TELEPHONE


STOP




OXY

ity. Topsoil texture may be classified as:

Light topsoil contains a high proportion of sand. It may be possible to mold it when moist, but it will lack cohesion and fall apart easily.

Medium topsoil contains a blend of soil textures. It can be easily molded when moist but it is not sticky and does not leave a smooth polished surface when smeared.

Heavy topsoil contains a high proportion of clay. It is sticky when moist, slippery when wet, and leaves a smoothed polished surface when smeared.

Topsoil may also be classified by pH and stone content.

Soil for ordinary use may include a few stones up to 5 cm or two inches in diameter. For turfgrass areas, the larger stones need to be removed. For athletic fields, playgrounds, or where body contact is made with the soil, stone-free soil is recommended.

E-1. Topsoil classified based on its pH.

Description	pH
alkaline	more than 7.5
slightly alkaline	7.0-7.5
slightly acid	6.0-7.0
acid	less than 6.0
strongly acid	less than 5.0

Stone is defined as any inorganic particle larger than 25 mm (1 inch). The size of gravel is 2-25 mm.

E-2. Topsoil classified as to content of stone

Class	% by weight
stone & gravel free	less than 1%
slightly stony	1-5
stony	5-20
very stony	20-50
extremely stony	over 50

F. Bulk Density

Well aggregated soils, when oven-dry, may have a bulk density of 75 to 95 pounds per cubic foot. These soils at field moisture capacity would be 90-115 pounds per cubic foot.

Loamy sand has a bulk density of 82-102 pounds

F-1. Bulk Density, Porosity, and Hydraulic Conductivity of a Loamy Sand Under Various Levels of Compaction.

Compaction Intensity	Bulk Density		Aeration Porosity	Hydraulic Conductivity
	cu. ft.	cc		
	lbs.	gm	%	inches/hr.
Lowest	82	1.31	21.5	6.5
		1.45	20.8	1.4
		1.49	10.0	0.9
		1.60	11.0	0.2
Highest	1.02	1.64	10.9	0.2