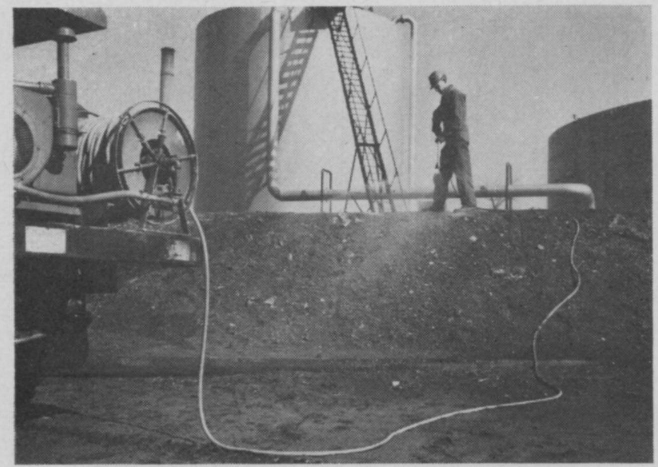
SOIL STERILIZATION for weed control . . .

What it means — What chemicals to use — When to apply —



Tank farms make good business for weed controllers.

SOIL sterilization consists of placing nonselective herbicides on or in the ground in such a manner that they will persist in the soil, clinging to soil particles so that both established plants and germinating seedlings will be killed.

This technique does not kill all life in the soil, in the normal sense of the word "sterile," but rather makes soil unfit for green plant life to survive. To be effective, an herbicide must be present so that no seedlings escape contact with it, or must be of such molecular structure that it is readily absorbed by developing seedlings.

Long-term sterilization herbicides are usually dependent upon rainfall or irrigation to leach or percolate the activated herbicide to that zone in the soil where it will affect the germination of seeds and kill established plants. Soil type interacts with herbicide solubility to affect the amount and speed of leaching. Light soils tend to hold herbicides less; heavy soils retain chemicals more readily. Light soils, however, are more easily treated because there are less microorganisms to act upon the herbicides.

Success of a soil sterilant herbicide is also dependent upon the ability of the compound to resist decomposition or breakdown by soil microorganisms, leaching, adsorption, chemical decomposition, and light deactivation.

Herbicidal compounds vary in their ability to sterilize soil. We will examine those compounds which are commonly used in what is termed industrial or noncropland soil sterilization after we examine the markets for this technique.

Most contract applicators are probably already aware of the potential market for soil sterilization. Industrial sites require semipermanent vegetation control when weeds become unsightly or interfere with safe operations. The oil industry, for example, engages contract applicators to control weeds on oil fields, around refineries, tank farms, and distributing and metering stations, so that fire hazard around flammable products will be reduced or eliminated.

Railroads, airfields, highways, power transmission lines, drainage canals, reservoirs, and other rights-of-way use weed control, including soil sterilization, to maintain unhampered and safe operations. Occasionally the food industry uses soil sterilization because less trouble from rodent predation results when adjacent weedy fields are cleared of weeds and accompanying rat harborages. Private and municipal recreational areas are using weed control, mostly selective, but sometimes a nonselective long-term type, to insure the comfort of patrons. See also *Weeds and Turf*, July 1962, page W-4, and August 1962, page W-4, for more market data.

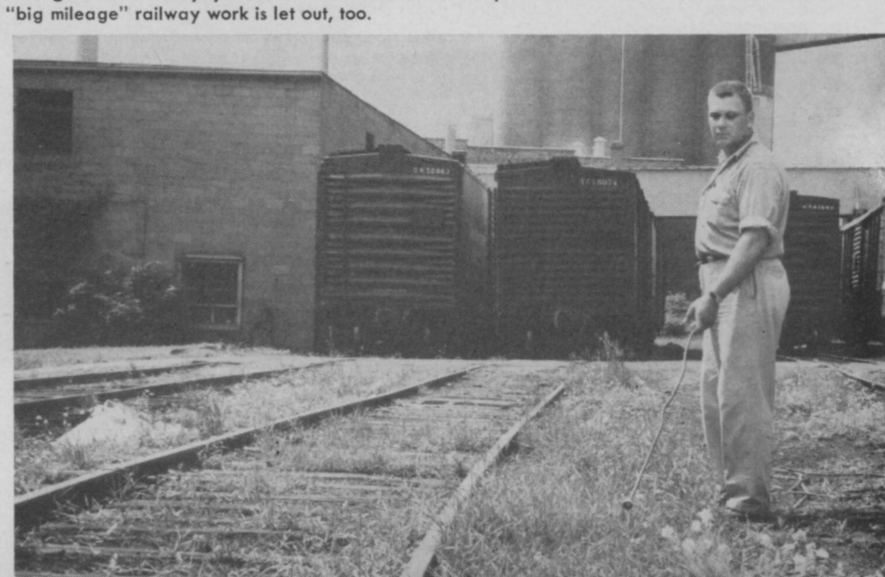
Since a "weed" is defined as any plant growing where it is not wanted, any site where plants cause trouble should be treated by a professional CA well versed in the fine points of soil sterilization.

There is an apparent simplicity implied by fact that "chemicals are sprayed and weeds don't grow." Although this may be true to a degree, there are several variables the successful CA must know about in order to eliminate the possibility of failure and expense of re-treatment or injury to desirable plants nearby.

All herbicides interrelate with rainfall, temperature, soil texture, fertility, application date, weed species, and weed tolerance, to challenge the applicator and his arsenal of weed weapons.

These variables, of course, differ with each geographical region and local area, so they are too numerous to be individually explained

Sidings and railway yards are often contracted to professionals for weed control. Much of the "big mileage" railway work is let out, too.



here. Variables are in effect, however, in all regions, so that the alert CA will be able to relate these differences to his area and the chemicals he uses; matching this with his own experience, he will gain valuable insight into his profession.

Chemicals used for soil sterilization can be divided into two large categories: inorganic, those compounds not containing carbon; and organic, those with the element carbon in the molecule.

Inorganic: Arsenic

Arsenic trioxide, As_2O_3, is the natural compound, long known for its poisonous properties, by which toxicity of arsenic compounds is gauged; As_2O_3 is the active ingredient. Since this chemical is relatively insoluble in water, it can be applied only in granular form to weeded areas in regions of low rainfall, such as the West. It gives long-term vegetation control. At approximately 800 pounds active ingredient per acre, arsenic trioxide will give excellent control of annual weeds for several years. Arsenic trioxide is partly absorbed by stems and leaves; mainly it is leached by rainfall to root areas where it is absorbed by roots. When sufficient herbicide accumulates in the plant's tissues, it dies.

Sterilizing sandy soils with arsenic trioxide is most efficient because the chemical is more available to plants. Greater amounts of arsenic trioxide are needed for heavy soils with high humus or clay content. In regions of high rainfall the longevity of arsenic is decreased by microbial decomposition.

Sodium arsenite, Na_2AsO_3, is produced when arsenic trioxide is reacted with sodium hydroxide, NaOH(lye). Sodium arsenite is more water soluble than arsenic trioxide and can be applied in a spray form. It has had a wide use in both selective and nonselective terrestrial and aquatic weed control. Because of its mammalian toxicity, however, its usefulness is waning. Other herbicides will perform the same job more safely and efficiently.

Inorganic: Sodium Chlorate

Sodium chlorate, $NaCl0_3$, is an effective soil sterilant with sufficient contact action to give foliage kill when applied as a spray. It is most useful for deep-rooted perennials, and is carried into the root zone by rain or leaching. If there is excess nitrate in the soil, killing action is reduced.

Roadways inside industrial parks must be kept weed free. This sprayman uses a truck-mounted boom for accessible, level areas; a small sprayer for the hard-to-reach slopes.

Therefore effective soil sterilization is dependent upon fertility of the soil. Excess nitrogen adversely affects the action and persistence of sodium chlorate in the soil, possibly because of the abundance of soil microorganisms.

Sodium chlorate is highly soluble in water which makes it possible to spray. A wetting agent or detergent increases its toxic action.

A drawback which makes this herbicide less desirable than others is that it is a powerful oxidizing agent and will ignite like a match if left to dry when on organic matter such as dry grass or clothing. It is said that the heat of the sun will ignite it. It is easy to extinguish with water but cannot be smothered because the chlorate carries with it its own oxygen in the molecule. There is no danger from pure or wet sodium chlorate. It will not burn or explode. Organic matter is necessary.

Compounds which absorb moisture, such as nonherbicidal calcium chlorate, are sometimes added to sodium chlorate to reduce this fire hazard. Borates are also combined with sodium chlorate for added protection against ignition. Sodium chlorate forms an essential part of such herbicide mixtures as "Chlorea," "Polyborchlorate," "Chlorax," and "Terratox."

Inorganic: Boron Compounds

Sodium borate, $Na_2B_4O_7$, is the anhydrous form (does not carry any H_2O with its molecule) of borax. It is a slowly leached, nonflammable, noncorrosive compound with low toxicity, which can be applied only in dry form. Three to 12 pounds per 100 sq. ft. will give sterility. Since borax is slowly leached and is not affected by soil microorganisms, it lasts about one year in moist warm soils, the most adverse conditions for a soil sterilant. Repeat applications the following year can be halved to maintain control.

To get a sprayable form of borax, hydrated forms are used. Sodium tetraborate, $Na_2B_4O_7 \cdot 10H_2O$, is more soluble than the anhydrous form. Disodium octaborate, tetrahydrate, and sodium metaborate are usually mixed 3 to 1 with sodium chlorate and eliminate the fire hazard of the latter chemical.

Solubility of borates is influenced by hydration. Hydrated forms of sodium pentaborate and sodium metaborate all have their uses in combination with other herbicides such as monuron, sodium chlorate, 2,4-D, and polychlorobenzoic acids.

Toxicity of borate to plants is related to clay content or texture of soils, whereas previously discussed herbicides depended upon nutrient content or fertility. The more clay in a soil, the more difficult it is to get satisfactory results.

As mentioned previously, borate persistence in the soil apparently stems from the chemical's inherent

This article was prepared by the technical staff of Weeds and Turf, *and reviewed by major suppliers and university researchers.*

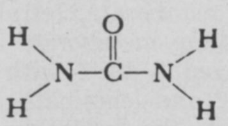
resistance to soil microorganisms which normally decompose or digest herbicides and make them nontoxic to plants. Additions of borates to other herbicides also increase their longevity in the soil, by inhibiting decomposition by soil organisms.

Organic: Substituted Ureas

There are four major substituted urea compounds, decreasing in solubility as follows: fenuron, monuron, diuron, and neburon. The two center compounds are selective herbicides commonly used at sufficiently high rates to act as nonselective chemicals and sterilize soils.

Fenuron, 3-phenyl-1,1-dimethylurea, is the most soluble of the four urea compounds. Its use is mainly for deep-rooted perennial and woody plant control. It is somewhat selective in this respect. We mention this compound because it illustrates how chemical researchers can work with a group of compounds and come up with several which appear to be similar, yet differ sufficiently to have slightly varied applications.

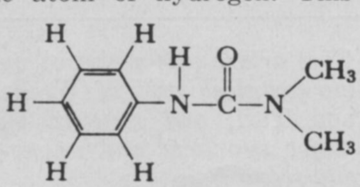
Urea is normally a nitrogen-furnishing fertilizer component. It looks like this:



urea

The C represents the element carbon; N, nitrogen; O, oxygen; and H, hydrogen. Lines between the atoms or elements represent the electrical bonds or links which hold the atoms together in a molecule.

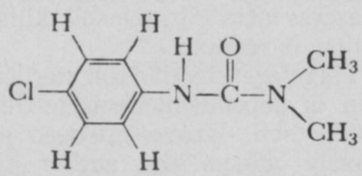
By a process known as substitution, chemists react urea, to which two methyl groups (CH_3) have already been substituted on the right end (1,1 position), with another chemical containing benzene, the hexagonal-shaped "phenyl" group. Researchers are thus able to produce a molecule where a phenyl group has replaced one atom of hydrogen. This is



fenuron

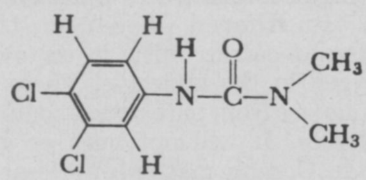
fenuron. The benzene ring which contains 1 carbon atom at each of the six corners and, normally 6 hydrogen atoms, is usually represented as an ordinary hexagon. The extra single lines also represent electrical bonds which hold the molecule together.

Monuron, 3-(4-chlorophenyl)-1,1-dimethylurea, is less soluble than fenuron. Ten to 50 pounds of active monuron per acre will control must vegetation. Monuron, like the rest of the substituted urea compounds, has a built-in resistance to decomposition under normal conditions. "Mono-" refers to the substitution of one chlorine atom on the phenyl group. The monuron molecule looks like this:



monuron

Diuron, 3-(3,4-dichlorophenyl)-1,1-dimethylurea, has the substitution of 2 atoms of chlorine; thus di-uron. It is even less water soluble than monuron. For this reason, it is preferred for soil sterilization at about 10 to 50 pounds active per acre in areas where there is more rainfall, and light sandy soils because it leaches less readily. Following the chemical substitution reaction, the original urea molecule has been transformed to:



diuron

Both monuron and diuron are absorbed by roots and are translocated to all parts of plants. Research indicates that the substituted ureas interfere with photosynthesis. Some workers feel that these herbicides prevent release of oxygen. This is a partial explanation of what causes death of weeds with substituted urea compounds.

Organic: 2,4-D Type Compounds

Fenac, 2,3,6-trichlorophenylacetic acid, is a growth regulator like 2,4-D, but is proving to be a longer lasting herbicide with special uses against perennial weeds.

Fenac is dependent upon rainfall for distribution throughout the soil where it has a contact effect on roots and germinating seedlings. Although it is one of the more persistent of the 2,4-D types, it requires repeated application for complete vegetation control. Rates of 15 to 30 pounds per acre will give soil sterilization.

Erbon, 2-(2,4,5-trichlorophenoxy)ethyl 2,2-dichloropropionate, is one example of organic synthesis where the molecules of two efficient weed killers, 2,4,5-T and dalapon, are combined into one large molecule with soil sterilant properties. Erbon is only slightly soluble in water and is available as an emulsion for use in water, or it can be applied in oil.

Applied as a spray at rates of 120 to 160 pounds of active ingredient per acre, it will eliminate all vegetation, and give extended control of germinating seeds.

Erbon does not move laterally on the soil as much as most herbicides and thus can be used with greater safety on smaller areas such as driveways around lawns where desirable vegetation is growing nearby.

Chlorobenzoic acids such as TBA, 2,3,6-trichlorobenzoic acid, and PBA, polychlorobenzoic acid, are effective soil sterilants at rates of 15 to 30 pounds per acre and 30 to 60 pounds per acre respectively.

They are especially effective against deep-rooted perennial weeds at these high rates.

TBA is the most potent of the possible chlorine-substituted benzoic acids. Depth of penetration depends upon rainfall and soil type, but the chlorobenzoics are persistent in the soil.

The same precautions must be taken when using these materials as with 2,4-D, namely avoidance of drift, and caution regarding the proximity to desirable species.

Tritac, 2,3,6-trichlorobenzyloxypropanol, is a new nonselective herbicide that will be available for the first time this season. Again the "2,3,6- trichlor" configuration should be noted. It is being recommended for deep-rooted perennials and will provide complete vegetation control at rates of 10 to

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30 pounds per acre. It will be available as an emulsifiable concentrate.

Organic: Symmetrical Triazines

Simazine, 2-chloro-4,6-bis(ethylamino)-s-triazine, applied at high rates, is an effective soil sterilant. Proven as a chemical cultivator, simazine at 10 to 40 pounds active per acre will sterilize soil where there is no problem of deep-rooted perennials. Simazine tends, because of its lack of solubility, to remain near the surface, killing annual weeds as they germinate. When weedkilling oils are added to simazine or atrazine, only 5 to 15 pounds of active ingredient need be applied for control. Generally two treatments, one month apart in early summer, will suffice.

Atrazine, 2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine, bears the same relationship to simazine as monuron does to diuron. Atrazine is more soluble than simazine, but both are applied at the same rates for soil sterilization.

Time to Apply

Generally, a good time to apply soil sterilants is before the weeds mature. The spring and fall are both good times to prevent weed growth. Application and complete soil coverage are easier without interference of full-grown weeds. Cooler temperatures are less conducive to bacterial action in the soil and therefore enhance the residual of an herbicide. But heavy snow and rain may leach the chemical away, so winter precipitation must be considered when chosing an overwinter herbicide.

Since soil sterilants are usually applied to relatively large areas, power equipment is considered the most economical. Either manually directed hoses or fixed booms would be satisfactory as long as even distribution is obtained. Broadcasting equipment such as Cyclone seeders and air guns are the most efficient for applying pelletized herbicides.

Nature of the chemical, time of year, soil type, temperature, the kind of weeds, and the size of the job will all help determine whether spray or dry preparations should be used.

Trimmings

Airing opinions. Two old pros at the Aquatic Weed Control Society meeting last month were applicators Henry Carsner and E. V. Scholl, who gave delegates some good pointers on equipment for waterweed jobs. Hank's specialty is development of air boats, which he works on at his Northwest Weed Control Company in Tacoma, Wash. Vic Scholl, a familiar person at meetings of aquatic applicators, runs Modern Weed Control in Grand Rapids, Mich. Both experts, while from widely separated parts of the country, have sound know-how in common, and the conference was enriched by their comments. Our reporter was on hand at the Chicago meeting, but because of an early presstime, we've saved our detailed report of what transpired there for next month.

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Pacesetting PCOs. We've been talking about PCOs who've branched into weed or turf and ornamental work quite a lot recently, and at the Purdue PCO Conference in January we ran into another versatile pest controller, Charles Warfield of Home Exterminating in Salisbury, Md. Chuck says one of his specialities is spraying golf course ornamentals for control of scales and other pests, and we wonder how many operators are looking into this new line. After all, it's a field which is coming rapidly into the fore. And what better way to spend an afternoon on the course than this, armed with spray gun, golf shoes, and a set of clubs!

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No sittting duck. William H. Drake, an entomologist who runs Drake Chemical Company in Perrysburg, Ohio, is another example of the versatility of spraymen today. Bill, who's a graduate entomologist, is nevertheless active in the weed control business on a custom basis. And if this isn't enough to keep him busy, he also manufactures and distributes chemicals and equipment for operators in the Great Lakes area. Obviously Bill's not a man to duck out of a time-consuming job!

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Take it for granted. Each year the North Central Weed Control Conference presents an award for the outstanding job done in weed control for the current year. Canadian Douglas H. Grant, agricultural representative for Swift in Saskatchewan, was the lucky winner for 1962, a Canadian correspondent just wrote us. Doug earned the honor through his efforts in which he (1) promoted a Canadian Weed Control Week, (2) helped organize 12 weed sprayer field days, and (3) sparked an essay contest on weed work among no less than 20 4-H clubs in the province to our north. Doug told about his "weed control week" at the conference last December, and we join other delegates in congratulating this hard-working benefactor of our industry.

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Raise a Furrer? Applicators in Jefferson County, New York, have lost a good right arm in former associate county agent Armin Furrer. We just learned that Armin recently accepted a position on the Agronomy Department staff at Cornell, where he'll work primarily with life history studies of perennial weeds. No doubt CAs who called on Mr. Furrer for help will miss his efforts, but it's good to know the big weed projects at Cornell will benefit from the former county agent's experience in the field.