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Garden Chemicals and Their Application

A *fungicide* is a toxicant or poison for fungi, a chemical or physical agent that kills or inhibits the development of fungus spores or mycelium. It may be an *eradicator*, applied to a plant, plant part, or the environment as a curative treatment to destroy fungi established within a given area or plant; or preferably it may be a *protectant*, applied to protect a plant or plant part from infection by killing, or inhibiting the development of, fungus spores or mycelium that may arrive at the infection court. A *bactericide* is a toxicant or poison for bacteria. Among the more recent bactericides are antibiotics, products of other living organisms. They also have value against certain fungi. There are also a few *virocides*, which are toxic or poisonous to viruses.

A *disinfectant* is an agent that frees a plant or plant part from infection by destroying the pathogen established within it. A disinfectant kills or inactivates organisms present on the surface of the plant or plant part or in the immediate environment. Chemicals for seed treatment can be either eradicants or protectants, but most of them are disinfectants, in that they kill organisms on the surface of the seed rather than those within. In common usage, however, they are called disinfectants.

A *nematicide* is, of course, a chemical that kills nematodes in the soil or in the plant. Most nematicides are *fumigants*, chemical toxicants that act in volatile form.

Not so long ago the chemicals on the garden medicine shelf consisted of copper and sulfur for protectants, lime sulfur as an eradicant, mercuric chloride as a disinfectant, and formalin and carbon bisulfide as fumigants. You sometimes got plant injury; you did not always get the best possible

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control, but at least you did not have to be an organic chemist. Now we have the following classes of fungicides:

Inorganic

1. Sulfur
2. Copper
3. Mercury (Discontinued)

Organic

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|--------------------------|-------------------------|
| 1. Dithiocarbamates | 7. Fumigants |
| 2. Thiazoles | 8. Antibiotics |
| 3. Triazines | 9. Dinitrophenols |
| 4. Substituted aromatics | 10. Quinones |
| 5. Dicarboximides | 11. Organotins |
| 6. Systemics | 12. Aliphatic nitrogens |

The search for new fungicides goes on, with hundreds of synthetic organic compounds being screened each year. This screening is often a cooperative venture between manufacturers, state experiment stations, and the U.S. Department of Agriculture. After safety precautions for the operator, and the effectiveness of a compound for certain diseases have been determined, the chief question is whether the material is *phytotoxic*, that is, injurious to plants, at concentrations required for control.

Phytotoxicity is an elusive factor, not to be pinned down in a few tests. It varies not only with the kind of plant but with the particular variety, the amount of moisture in the soil when the spray is applied, the temperature, whether or not the application is followed by rain or high humidity, the section of the country, and the compatibility of the chemical with spreaders or wetting agents, as well as with other fungicides or insecticides. Coordinated tests with new materials in many different states are extremely valuable. Some compounds give rather uniform results over the country; others vary widely with climatic conditions.

The 1947 Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) provides that all fungicides must be registered with the U.S. Department of Agriculture before being marketed. Materials highly toxic to humans must be prominently marked, instructions given for avoiding injury to plants or animals, the toxicant chemical named, and the percentage of active or inactive ingredients given. All labels submitted for registration must be accompanied by some sort of proof that the claims for performance are valid.

In 1954, Public Law 518, known as the Miller Bill, was passed, providing for tolerances. A tolerance is the legal limit of a poisonous residue, expressed in parts per million (ppm), that may remain on an edible product at the time it is distributed for consumption. In 1958, the Food Additives Amendment was passed, which also controls pesticide residues in processed foods. It included

the Delaney clause, which states that any chemical found to be a carcinogen in laboratory animals may not appear in a human food.

In 1959, the FIFRA was amended to include nematocides, plant growth regulators, defoliants, and dessicants as pesticides. Since that time, poisons and repellents used against all classes of animals (from invertebrates to mammals) have been brought under control.

FIFRA was further amended in 1972 as the Federal Environmental Pesticide Control Act (FEPCA), making violations by growers, applicators, or dealers subject to heavy fines and/or imprisonment. All pesticides had been classified into either general-use or restricted-use categories by October 1977, with anyone applying restricted pesticides required to be state-certified. Pesticide manufacturing plants are to be registered and government-inspected. All pesticide products must be registered whether shipped in interstate or intrastate commerce. Other provisions are of various degrees of importance to concerned persons or companies.

Additional modifications were made in FIFRA in 1989. The modifications specifically will (1) accelerate reregistration of older pesticides (those registered prior to November 1984) and impose fees on chemical manufacturers for reregistration; (2) essentially eliminate indemnification payments to those holding inventories of suspended or canceled pesticides, except farmers and "certain end users"; and (3) shift part of the burden for storage and disposal of banned pesticides from the government to the manufacturer. The 1989 FIFRA also empowers the Environmental Protection Agency (EPA) to change regulations on how applicators handle, rinse, and dispose of pesticide containers. In the next five years EPA will be determining ways to maximize reuse and refill of containers, minimize disposal of containers, and maximize containment of rinsing. EPA is expected to report to Congress on the progress made on these issues by December 1990.

The federal government considers these to be minimum pesticide regulations. Any state may choose to establish more rigid pesticide regulations within its boundaries than those legislated by the federal government, and some have done so. Some states require notification to be posted prior to commercial pesticide application including chemicals used. Thus, pesticide applicators must be familiar with individual state pesticide regulations as well as federal pesticide regulations.

Consumers, therefore, are well protected against fraud, but they must be willing to read the fine print on labels if they are to choose intelligently from the bewildering array of proprietary compounds on dealers' shelves. And they must also read the fine print and follow directions exactly if their homegrown vegetables are to be as safe for consumption as those from commercial growers who have to comply with the law in the matter of residues.

Even if you follow exactly the directions for dosage given on the label, you may have some plant injury under your particular combination of soil, weather, and kinds of plants. Keep a notebook. Put down the date you

sprayed, the dosage used, the approximate temperature and humidity, whether it was cloudy or sunny, in a period of drought or prolonged wet weather. Go around later and check for burning; for leaf spotting and defoliation from the spray or from failure to control the disease; for leaf curling or stunting; for too much unsightly residue. Note which varieties can take the spray and which cannot.

The following alphabetical list includes chemicals now commercially available, a few that are rather outmoded but still found in textbooks, a few that were marketed in the past but have now been discontinued, and a few that will probably be marketed before this text is published. By that time there will be many more that should have been included, for the search for better chemicals is unending. There will also be more that will be discontinued. The list presented herein must be considered only as a guide. Exclusive reliance must be placed on directions and information supplied by the manufacturer or by agricultural specialists, agents, or advisors. *Be sure to read the label.*

Because so many of the new compounds have long, complex chemical names, they have been given short common names by the American Standards Association. Such common names are not capitalized. Frequently, however, no official common name has yet been given to a product, and so the trade name is used as a common name, in which case it should be capitalized. For a comprehensive list of proprietary chemicals and mixtures of pesticides see *Pesticide Handbook*, compiled annually by Dr. E. E. H. Frear and available by writing to College Science Publishers, State College, PA. 16801. The *Farm Chemicals Handbook*, which is published each year by Meister Publishing Co., 37841 Euclid Ave., Willoughby, OH 44094, also gives an up-to-date listing of pesticides.

FUNGICIDES

AATack. See Thiram.

Aaterra. See Koban.

AC 5223. See Dodine.

Acarelte. See Dinobuton.

Acarelte forte. See Dinobuton.

Acetic acid. Present in vinegar, one of the oldest preservatives, formerly used to some extent for damping-off of evergreen seedlings.

Acrex. See Dinobuton.

Acti-dione. See Actidione.

Actidione (discontinued 1987 by Nor-Am Chemical Co.). Cycloheximide, from *Streptomyces griseus*, the first antibiotic introduced (1949) for control of plant disease. Effective in control of powdery mildews, cherry leaf spot, cedar-apple rusts (applied to juniper host to prevent spore horns), white pine blister rust (for treating cankers), turf diseases. Available in different formulations: Actidione Ferrated, with ferrous sulfate for dollar spot, fading out, melting out of turf; Actidione RZ, with pentachloronitro-

benzene for azalea petal blight, brown patch, and other turf diseases; Actidione PM, with a safener to prevent phytotoxicity when used for powdery mildew of roses and other ornamentals; in combination with Thiram as Actidione Thiram; also Actispray, Acti-dione TGF and Hizarocin.

Acquinite. See Chloropicrin.

Actispray. See Actidione.

Afugan (Hoechst AG, West Germany). 0,6-ethoxycarbonyl-5-methylpyrazolo [1,5, -a] pyrimidin-2-yl 0,0-diethyl phosphorothioate), for control of powdery mildew on cucumber, melon, pumpkin, squash, watermelon, ornamentals, strawberry, apple, grape, and so on. Other names: Curamil and Hoe 002873.

Agri-Mycin 17. See Streptomycin.

Agri-Strep. See Streptomycin.

Agrosol S (discontinued 1984 by Chipman Chemical, Inc.). Combination of maneb and captan. Protective seed treatment for corn, peas, beans, including damping-off, seed decay organisms, and seed blight.

Agrox Strep (discontinued by Chipman Chemical, Inc.). Combination bactericide and fungicide, seed treatment of beans where halo blight is a problem. Registered only in Michigan.

Agrox 2-Way (Chipman Chemical, Inc.). Combination of captan and diazinon. Protective seed treatment for corn, peas, and beans.

Agrox 3-Way (discontinued 1985 by Chipman Chemical, Inc.). Combination of captan, lindane, and diazinon. Protective seed treatment for corn, peas, and beans.

Airone. See Antracol.

Akzo Chemie Maneb. See Maneb.

Allisan. See DCNA.

Ammonium Sulfate. Used around trees and shrubs affected with *Phymatotrichum* root rot.

Amobam (Artel Chemical Corp.). Diammonium ethylene bisdithiocarbamate. Used for damping-off and some vegetable blights; forms zineb in a tank mix with zinc sulfate. Other name: Chemo-O-Bam.

Anisomycin (Chas. Pfizer). Antibiotic from *Streptomyces griseolus*. Has controlled apple powdery mildew but is phytotoxic; effective for bean rust and anthracnose. See also Streptomycin.

Antracol (Bayer AG, West Germany; Agrimont S.p.A., Italy; Visplant Chimiren S.r.l., Italy). Zinc-N,N'-propylene-1,2-bis-(dithiocarbamate), used for downy mildew and red fire disease of grape vines, early and late blights of potatoes and tomatoes, blue mold of tobacco, and Sigatoka disease of bananas. Other names: Airone; Bay 46131; LH 30/Z; Taifer.

Apadodine. See Dodine

APL-Luster. See Thiabendazole.

Arasan (discontinued by DuPont). Tetra-methyl thiuram disulfide (thiram). Seed treatment for peanut, corn, bean, pea, beet, carrot, and other vegetables and flowers; used mixed with fertilizer for onion smut control.

Arbotect. See Thiabendazole.

Aspor. See Zineb.

Aules. See Thiram.

Avicol. See PCNB.

Award. See Penconazole.

Banol Turf Fungicide. See Propamocarb hydrochloride.

Banrot (Sierra Chemical Co.). 5-ethoxy-trichloromethyl-1,2,4-thiodiazole, 15%; dimethyl 4,4'-oxydiphenylenebis (3-thioallophanate), in a 3 to 5 ratio.

Used as a soil drench for control of damping-off, root and seed rot diseases.

Bardac (Lonza, Inc.). Quaternary ammonium compounds.

Barquat Compounds (Lonza, Inc.). Quaternary ammonium compounds.

Germicidal effectiveness against a wide variety of microorganisms in anti-septics, germicides, algicides, deodorants, and detergent-sanitizers.

BASF-Maneb Spritzpulver. See Maneb.

Basfungin (discontinued by BASF Aktiengesellschaft, Federal Republic of

Germany). Coprecipitation of zinc ammonia propylene-bio-dithiocarbamate + polypropylene-bis-thiocarbamoyldisulfide. Used for control of fungus diseases of grapes and hops.

Bavistin. See Carbendazin.

Bay 4631. See Antracol.

Bay 47531. See Euparen.

Bay 49854. See Euparen M.

Bay 572. See Euparen M.

Baycor (Bayer AG, West Germany; Mobay Corp.). *B*-[+1, 1'-biphenyl]-4-xloxy)- α (1, 1 dimethylethyl) 1H-1, 2, 4-triazole-1-ethanol. Used for scab and *Monilinia* on pome and stone fruit; leafspot diseases and powdery mildew on stone fruits, bananas, vegetables, sugar beets, peanuts, and ornamentals.

Bayleton (Bayer AG, Federal Republic Germany; Mobay Corp.). 1-(4-chlorophenoxy)-3,3-dimethyl-1-(1,2, 4-triazol-1-yl)-butan-2-one. Used on mildew and rust affecting vegetables, grapes, and ornamentals.

Benlate, benomyl (Du Pont). Methyl 1-(butylcarbamoyl)-2-benzimidazole-carbamate. Highly active fungicide with systemic, residual, and curative properties, also ovacidal for mites, of low order of toxicity to plants and animals although phytotoxicity has been reported. Especially effective for powdery mildew, brown rot, *Cercospora* and cherry leaf spots, rose black spot, Botrytis blights, and club root. Other names: Benex, Benor, Tersan 1991.

Benomyl. See Benlate.

Bentonite (Applied Industrial Materials Corp.; Lowe's Industrial Products).

Hydrated aluminum silicate, a clay mineral used as a diluent in dusts.

Benzimidazoles. A group of systemic fungicides including benomyl (Benlate), thiabendazol (Mertect), thiophanatemethyl, and OM 2424 (Terrazole).

Binapacryl. Sold as Morocide (discontinued 1987 by Hoechst AG, F.R.G.). 2-sec butyl-4,6-dinitrophenyl-3-methyl-2-butenolate. Miticide also used for powdery mildew, registered for apples and other fruits.

- Bioguard.** See Thiabendazole (discontinued by Merck Chemical Div.).
- Bioquin 1** (Monsanto). Copper oxinate or copper 8-quinolinolate organic fungicide; has been used for sycamore anthracnose, avocado fruit rot.
- Biotrol-Plus** (Nutrilite Products, Inc.). Contains *Bacillus thuringiensis* 1.2% with pyrethrins 2.0% in petroleum distillate for insecticide. Used for control of cabbage loopers, cabbage worms, leaf rollers, leaf hoppers, thrips, aphids, and certain insects on ornamental flowers, cole crops, celery, tomatoes, and potatoes.
- Biotrol VHZ** (discontinued 1985 by Zoecon Corp.). Contains Heliothis Polyhedrosis Virus. Used for bollworm and corn earworm.
- Biotrol XK** (discontinued by Nutrilite Products, Inc.). *Bacillus thuringiensis*.
- Borax** (Kerr-McGee Chemical Corp.). Used as a wash for citrus fruit molds, a dip for sweetpotato sprouts, in boron-deficient soils for black heart of beets, cracked heart of celery, internal cork of apples.
- Bordeaux mixture** (Leffingwell, Uniroyal Chemical Co.). Mixture of hydrated lime and copper sulfate; or as produced, for example, a fixed copper fungicide with 12.75% copper (elemental) content. Prepared from copper sulfate and lime to form a membranous coating over plant parts, the first protective spray and still widely used. About 1878, French vineyards were threatened with downy mildew, which had been introduced from the United States. Millardet, one of the workers assigned to the problem, noticed that where grapes near the highways to Bordeaux had been treated with a poisonous-looking mixture of copper and lime to prevent stealing, there was little or no downy mildew. A description of the preparation of bordeaux mixture was published in 1885, and it remains a most efficient fungicide. It does, however, have a most conspicuous residue, and is injurious to some plants.

Bordeaux mixture is made in varying concentrations. The most usual formula is 8-8-100 (often stated as 4-4-50), which means 8 pounds copper sulfate, 8 pounds of hydrated lime to 100 gallons of water. Stock solutions are made up for each chemical (1 pound per gallon of water), the lime solution placed first in the sprayer, diluted to nearly the full amount, and the copper sulfate solution added. Or, for power sprayers, finely divided copper sulfate (snow) can be washed through the strainer into the spray tank, and when the spray tank is two-thirds full the weighed amount of hydrated lime can also be washed through the strainer while the agitator is running. Casein or other spreader is added toward the end.

For ornamentals, a 4-4-100 is usually strong enough and can be made in small amounts by dissolving 2 ounces of copper sulfate in 1 gallon of water, 2 ounces of hydrated lime in 2 gallons of water, pouring the copper sulfate solution into the lime water, and straining into the spray tank through fine cheesecloth.

For some plants, as stone fruits, the proportion of lime is increased; for others, as azaleas, a low-lime bordeaux is used. Once the two solutions have been mixed, the preparation must be used immediately. Fresh lime is

essential, not some left over from a previous season. Somewhat less effective than homemade bordeaux but easier for the home gardener are the various powders and pastes available under trade names; to these add only water at the time of use.

Phytotoxicity comes from both the lime and the copper. Plants are often stunted, with yield reduced; fruit-setting of tomatoes may be delayed. Bordeaux is not safe on peaches during the growing season, may burn and russet apples (both foliage and fruits), may cause red spotting, yellowing, and dropping of rose leaves (often confused with blackspot by amateur and sometimes professional gardeners), and may cause defoliation of Japanese plums. Injury is most prominent early in the season when temperature is below 50°F and in dull, cloudy weather when light rain or high humidity prevents rapid drying of the spray. Late summer use of bordeaux is credited with making some plants more susceptible to early fall frosts. Other name: Bordocop.

Bordeaux-oil emulsion. For citrus fruits. Enough oil emulsion is added to the dilute bordeaux mixture to make 1% actual oil. The copper kills the beneficial fungi, keeping down scale insects, so the oil is added to kill the scales.

Bordeaux paint. Raw linseed oil is stirred into dry bordeaux powder until thin enough to apply with a brush to pruning wounds, especially those on apple trees after pruning for fire blight.

Bordeaux wash. Water is added to dry bordeaux powder and half as much lime until the mixture is like thin paint. It is applied to the lower trunks of citrus trees to prevent brown rot gummosis.

Bordocop. See Bordeaux mixture.

Botran (Nor-Am Chemical Co.). See DCNA.

Botrilex (Uniroyal Chemical Co.). See PCNB.

Brassicol (discontinued 1985 by Hoechst A G). See PCNB.

Bravo (Fermenta Plant Protection Co.). Tetrachloroisophthalonitrile. Used as a broad-spectrum fungicide on snap beans, cole crops, carrot, celery, sweet corn, cucumber, onion, cantaloupe, muskmelon, honeydew, watermelon, squash, pumpkin, peanut, potato, tomato, turf, and ornamentals. Other names: Clorto Caffaro, Clorto Caffaro Flow, Clortocaf Romato, Clortosip, Daconil 2787, Exotherm Termil, Turfcide.

Brestan (Hoechst AG, F. R. G.). Triphenyltin acetate. Effective for pecan scab, potato late blight, downy mildew of cucumbers; slightly phytotoxic.

Brestanid. See Du-Ter.

Bromofume. See Ethylene dibromide.

Brom-O-Gas. See Methyl bromide.

Brom-O-Gaz. See Methyl bromide.

Bromoethane. See Methyl bromide.

Brom-O-Sol (Great Lakes Chemical Corp.). Contains methyl bromide 68.6%, chloropicrin 1.4%, organic solvent 30%. Used to control soil-borne diseases,

- nematodes, and insects. Growth difficulty may be experienced on carnations, holly, snapdragons, and multiflora rose. Apply at least 18 inches from plants to be maintained.
- Bupirimate** (ICI Agrochemicals). 5-butyl-2-ethylamino-6-methyl-pyrimidin-4-yl-dimethylsulfamate. Systemic fungicide for control of powdery mildew of fruit and ornamentals. Other name: Nimrod.
- Burcop**. See Burgundy mixture.
- Burgundy mixture** (La Cornubia S.A.). A soda bordeaux formerly used, prepared with washing soda instead of lime. Other names: Comac, Burcop.
- Busan 72 A** (Discontinued by Buckman Laboratories, Inc.). 2-(thiocyanomethylthio) benzothiazole. Used for treatment of pine, fir, and cotton seed and as a soaking treatment for iris, narcissus, tulip bulbs, and gladiolus corms.
- Caddy** (W. A. Cleary Chemical Corp.). Contains 20.1%, equivalent to 12.3% elemental cadmium. Used for control of dollar spot, copper spot, Helminthosporium, and Curvularia leaf spots on turf. Other names: Cadmium chloride, Vi-Cad.
- Cadminate** (Mallinckrodt, Inc.). Cadmium succinate, used for dollar spot, copper spot, red thread, and snow mold of turf.
- Cadmium chloride**. See Caddy.
- Cadmium sulfate**. 14% solution. Used for painting bark surface in infected areas of apple, pear trees.
- Cad-Trete** (W. A. Cleary Chemical Corp.). Thiram and cadmium chloride hydrate. Used as multipurpose turf fungicide.
- Calcium sulfide**. Gives good control of apple scab.
- Calixin** (BASF AG, F. R. G.). Reaction mixture of C₁₁-C₁₄ 4-alkyl-2,6-dimethylmorpholine homologues containing 60% to 70% of 4-tridicyl isomers. Systemic fungicide with protective, curative properties. Controls wide range of diseases (black sigatoka, pink disease, powdery mildew, rust), of economic importance to fruit (bananas, mango), vegetables (cucurbits).
- Caocobre**. See Copper oxides.
- Captafol**. See Difolatan.
- Captan**. N-trichloromethylthiotetrahydrophthalimide, sold as Orthocide Garden Fungicide (Chevron Chemical Co.). Used extensively for control of many fruit and vegetable diseases—apple scab, peach brown rot, cherry leaf spot, black rot of grapes; for bluegrass melting-out and other turf diseases; for rose blackspot. Also used as a seed protectant and for conifer and other seedlings to prevent damping-off. It is of questionable compatibility with oils, dinitros, alkaline materials.
- Capthion** (ICI Australia Ltd.). Mixture of captan, sulfur, and malathion. Used for control of home garden diseases and insects. Not available in the United States.
- Carbam**. See Metam-sodium.

Carbamate. See Ferbam.

Carbendazin (Hoechst AG, F. R. G.; BASF AG, F. R. G.; DuPont). 2-(methoxycarbonylamino)-benzimidazole. Controls wide range of Ascomycetes and Fungi Imperfecti and numerous Basidiomycetes. Used on vegetables, fruits, ornamentals, and turf. Other names: Bavistin, Delsene, Derosal, Equitdazin, Hoe 017411.

Carbon disulfide (ICI Americas). Soil fumigant used for control of *Armillaria* root rot and sometimes for nematodes. This chemical is highly inflammable, also dangerous to living plants. Use only on fallow soil.

Carboxin. See Vitavax.

Carpene. See Dodine.

Casein. One of the proteins in dried skim milk, used as a spreader for sprays, to reduce surface tension.

Cela W 524. See Triforine.

Celfume. See Methyl bromide.

Cercobin. See Thiophanate.

Cercobin M. See Thiophanate-methyl.

CGA 38140. See Fongarid.

CGA 48988. See Metalaxyl.

CGA 71818. See Penconazole.

Chem Bam. See Nabam.

Chem Neb. See Maneb.

Chem-O-Bam. See Amobam.

Chemsect. See Dinitro compounds.

Chem Zineb. See Zineb.

Chinosol (Probelte, S. A.). 8-Hydroxyquinoline sulfate. Soil control of certain vascular wilts on citrus, fruit trees, vegetables, vine. Bacterial diseases of plants, fungus on cutting flowers.

Chipco 26019. See Iprodione.

Chipco 26019 Flo. See Iprodione.

Chipco Spot Kleen (discontinued by Rhone-Poulenc Inc.). 4,4'-0-phenylenebis (3-thio) allophanate. Used to control major turf diseases on golf course greens, tees, and fairways.

Chipco Thiram 75. See Thiram.

Chloranil (Uniroyal). Tetrachloro-para-benzoquinone, sold as Spergon. Seed protectant to prevent damping-off of peas, beans, soybeans, corn, peanuts; root and sprout dip for sweet potatoes; bulb dip; fungicide for turf brown patch and dollar spot. Other name: Spergon.

Chloroneb (Kincaid Enterprises, Inc.). 1,4-dichloro-2,5-dimethoxybenzene. Used for treatment of turfgrass to control snow mold (*Typhula*) and Pythium blight.

Cloro-O-Pic. See Chloropicrin.

Cloro-O-Pic 70. See Chloropicrin.

Chloropicrin (Great Lakes Chemical, Corp.). Tear gas, sold as Larvacide, fumigant for nematodes and some fungi, particularly *Sclerotium rolfsii*, not to be used around living plants. The soil should be prepared as for planting and be moderately loose. Spot injections, 10 inches apart, are made with a hand applicator resembling a huge hypodermic needle, 6 inches deep. It helps to mark the area like a checkerboard with crosswise and lengthwise lines 10 inches apart. On the first row injections are made at the intersections of lines, on the next row they are staggered halfway between; they are again at the intersections on the third row, and so on. Tear gas is disagreeable to handle and must be applied with the special applicator, which can be rented. A gas mask is required for application. The gas works much better at high temperatures, with most rapid killing of root-knot nematodes at 98° F. Chloropicrin should not be used in early spring before the ground has warmed to at least 60° F. The soil should be moist. Apply a water seal immediately after smoothing the soil, wetting the surface for an inch or more. A delay of 2 hours after injection before adding water means a great reduction in effectiveness. Other names: Acquinite, Chlor-O-Pic, Chlor-O-Pic 70, Dojyopicrin, Dolochlor, Larvacide, Pic-Clor, Tri-clor.

Chlorothalonil. See Bravo.

Clorto Caffaro. See Bravo.

Clorto Caffaro Flow. See Bravo.

Clortocof Ramato. See Bravo.

Clortosip. See Bravo.

Comac. See Burgundy mixture.

Cop-O-Cide (discontinued by Tower Chemical Co.). An emulsion of copper salts of fatty and rosin acids.

Copper Acetate. First developed by 1889; became the first factory-made basic copper fungicide.

Copper ammonium carbonate (Mineral Research and Development Corp.). An aqueous blue liquid containing 8% copper as active fungicide. Available as Copper-Count-N.

Copper Carbonate, Basic (Uniroyal Chemical Co.; Tennessee Chemical Co.). Basic cupric carbonates. Used as a seed treatment. Controls smut diseases of grasses. Applied as early-season sprays for tree fruits and nuts. Used to impregnate pear wraps.

Copper chloride, basic. See Copper oxychloride.

Coppercide. See Copper Sulfate, Basic.

Copper compounds. So-called fixed coppers, more stable than bordeaux mixture, less phytotoxic, easier to use, and with less objectionable residue. They include basic sulfates (Tennessee Tribasic, Basicop), basic chlorides (Copper-A Compound, C—O—C—S), copper oxides (Cuprocide), copper ammonium silicate (Coposil), copper zeolite, and copper phosphate. Copper sprays control many blights, leaf spots, downy and powdery mildews.

They are incompatible with lime sulfur, questionable with cryolite, benzene hexachloride, tetraethyl pyrophosphate, organic mercuries, and dithiocarbamates. They may injure plants in cool, cloudy, or moist weather. Injury to apple and rose foliage varies from reddish spots to yellowing and defoliation.

Copper-Count-N. See Copper ammonium carbonate.

Copper-Count-NS. See Copper ammonium carbonate.

Copper-fixed (Agtrol Chemical Products; Tennessee Chemical Co.). Includes basic sulfates, oxychlorides, and oxides. Developed to replace bordeaux mixture.

Copper hydroxide (Agtrol Chemical Products; Griffin Corp.). Cupric hydroxide. Used as general fungicide on many fruit, vegetable, and ornamental plants. Available in various formulations: Kocide 101, Kocide 404, Kocide SD, Kocide 404S, Kocide 101S.

Copper-lime dust. Usually prepared of 20% monohydrated copper sulfate and 80% hydrated lime, sometimes used on potatoes and other vegetables as a substitute for bordeaux mixture. It is more effective applied when foliage is wet.

Copper naphthenate (Agtrol Chemical Products; Troy Chemical Corp.). Chiefly a preservative for wood and fabrics but tested as a fungicide in aerosol sprays.

Copper Nordox. See Copper oxides.

Copper oxides (Agtrol Chemical Products; CP Chemical Corp.). Cuprous oxide; cupric oxide. Used as a seed treatment to control damping-off and as a dust to control vegetable and fruit diseases. Other names: Caocobre, Copper Nordox, Copper-Sandoz, Fungi-Rhap, Nordox SD-45, Nordox SD-50, Oleocuiivre, Oleo Nordox, Yellow Cuprocide.

Copper oxychloride. Solution used on potatoes and tomatoes.

Copper Power. See Copper Sulfate, Basic.

Copper Pride. See Copper Sulfate, Basic.

Copper-Sandoz. See Copper oxides.

Copper Sulfate, Basic (Agtrol Chemical Products; CP Chemical, Inc.; Old Bridge Chemical; Tennessee Chemical Co.). Contains a minimum 53% copper (metallic basis). Used widely to control citrus diseases, bacterial and fungus diseases of tomatoes and peppers as well as fruit, vegetables, and ornamentals. Other names: Coppercide, Copper Pride, Copper Power, CP Basic Copper TS-53 WP, KOP 300, Phyto-Bordeaux, Super CU, Tennessee Brand Tri-Basic Copper Sulfate 53 WP, TNCS 53, Tricop.

Corozate. See Ziram.

CP Basic Copper TS-53WP. See Copper Sulfate, Basic.

Crisfolatan. See Difolatan.

Crotothane. See Karathane.

Cryptonol (discontinued by Midox Ltd.). Potassium hydroxyquinoline sulfate. Used as a soil drench, dip, or spray for control of fungal and bacterial diseases or as a glass-house disinfestant.

- Cufram Z** (Universal Crop Protection Ltd.). Dithiocarbamate complex containing copper, manganese, iron, and zinc. Used to control potato blight, mildew of hops, apple scab, blackcurrant leafspot, downy mildew of vines.
- Cufraneb.** See Cufram Z.
- Cuman.** See Ziram.
- Cumene.** See Zineb.
- Curamil.** See Afugan.
- Curitan.** See Dodine.
- Curzate M.** See Mancozeb; Maneb.
- Curzate M8.** See Mancozeb.
- Cycloheximide.** See Actidione.
- Cyclomorph.** See Dodemorph.
- Cyprex.** See Dodine.
- Daconil 2787.** (Fermenta Plant Protection Co.). Tetrachloroisophthalonitrile. Broad-spectrum foliage and fruit protectant, registered for turf and certain ornamentals, controlling various vegetable and fruit diseases. Used as a thermal dust in greenhouses under name of Termil. See also Bravo.
- Dazomet** (BASF AG; Hopkins Agri. Chem. Co.; ICI Americas, Inc.; UCB Chem. Corp.). Tetrahydro-3,5-dimethyl-2H-thiadiazine-2-thione. Used to control soil fungi, nematodes, weeds, and soil insects; preplant treatment for turf and ornamentals.
- DCNA** (Nor-Am Chem. Co.). 2,6-dichloro-4-nitroaniline. Active against *Botrytis*, *Monilinia*, *Rhizopus*, *Sclerotinia*, and *Sclerotium* species. Used on apricots, blackberries, boysenberries, carrots, cucumbers, garlic, grapes, lettuce, nectarines, onions, peaches, plum, prune, potatoes, red raspberries, rhubarb, snap beans, sweet cherries, tomatoes, sweet potatoes, and ornamentals. Other names: Allisan, Botran, Kiwi Lustr 277, Resisan.
- Dehydroacetic acid.** 3-acetyl-6-methyl-2,4 pyrandione. Mold preventative used for processed fruits and vegetables; formerly used as a dip or wrapper impregnant.
- Deksonal.** See Lesan.
- Delan.** See Dithianon.
- Delan-Col.** See Dithianon.
- Delsene.** See Carbendazin.
- Demosan.** See Chloroneb. Discontinued by DuPont.
- Denarin.** See Triforine.
- Desain.** See Dinobuton.
- Devizeb.** See Zineb.
- Dexon** (discontinued by Chemagro, Bayer AG). *p*-dimethylaminobenzene diazo sodium sulfonate. Nonmercurial seed and soil fungicide available as wettable powders, as granules, and mixed with PCNB. Used to control damping-off and *Pythium* and *Phytophthora* root rots. A practical soil drench for container-grown plants.
- Diazoben.** Discontinued.
- Dicamate.** See Karamate; Mancozeb.

Dichlofluanide. See Euparen.

Dichlone (discontinued by Uniroyal). Common name for 2,3-dichloro-1,4-naphthoquinone, sold as Phygon (Uniroyal). Used for early-season control of fruit diseases, sometimes for celery and tomato blights, and for seed treatment. It is effective in control of rose blackspot and azalea petal blight but slightly phytotoxic. Other name: Phygon.

Dichloran. Common name for 2,6-dichloro-4-nitroaniline, DCNA, and sold as Botran (Nor-Am Chem. Co.). Effective for Botrytis, Sclerotinia, and related blights on fruits, vegetables, and ornamentals. Can be used as a spray or dust in the field and as a postharvest dip.

Dichloropropene. See Telone C.

Diethofencarb (Sumitomo Chem. Co.). Isopropyl 3, 4-diethoxyphenylcarbamate. Use for benzimidazole-resistant strains of various fungi. Strong activity against strains of *Botrytis cinerea*.

Difolatan (ICI Agrochem.; Chrystal Chem. Inter-America; Sunko Chem. Co.). Folcid, *cis*-N-[(1,1,2,2-tetrachloroethyl)thio]-4-cyclohexene-1,2-dicarboximide. Useful for control of foliage, soil, and seed diseases; registered for early and late blight on potatoes; good for downy mildews and various other fruit and vegetable diseases and for turf. Discontinued names: Difolatan, Folcid. Other names: Captafol, Foltaf, Haipen, Mycodifol, Sanspor.

Dikar (Rohm & Haas). Coordination product of zinc ion, dinitro (1-methyl heptyl) phenyl crotonate, and manganese ethylene bisdithiocarbamate. Especially recommended for apples, to control scab, mildew, rust, and brown rot.

Dimethirimol. See Milcurb.

Dinitro compounds (A. H. Marks & Co., Ltd.; Pennwalt Holland B.V.; Tifa Ltd.). Derivatives of cresol and phenol used as dormant sprays for some insects, as herbicides, and occasionally as eradicant fungicides. See also Elgetol. Other names: Chemsect, DNOC, DNC, Elgetol 30, Nitrador, Selinon, Sinox, Trifocide, Trifrina.

Dinobuton (Keno Gard AB, Sweden). 2-(1-methyl-2-propyl)-4,6-dinitrophenyl isopropylcarbonate. Used to control powdery mildew on apples, cucumbers, and hops. Other names: Acaelte, Acaelte Forte, Acrex, Desain, Dinofen, Dravinol, Talan.

Dinocap. See Karathane.

Dinofen. See Dinobuton.

Dipher. See Zineb.

Direx. See Dyrene.

Dithane D-14. See Nabam (Discontinued 1987 by Rohm and Haas Co.).

Dithane M-22. See Maneb.

Dithane M-22 Special. See Maneb.

Dithane M-45 (Rohm & Haas). Coordination product of zinc ion and manganese ethylene bisdithiocarbamate, related to both maneb and zineb. Used as a protectant against a wide spectrum of diseases of many fruit and vegetables. Other names: Mancozeb, Manzate 200, Nemispor, Penncozeb, Policar MZ, Policar S, Riozeb, Vondozeb Plus, Ziman-Dithane.

- Dithane Z-78** (Name discontinued). See Zineb.
- Dithianon** (Shell Agrar GMBH & Co. KG). 5,10-dihydro-5,10-dioxonaphtho-(2,3b)-*p*-dithiin-2,3-dicarbonitrile. Effective against many diseases of pome fruit, stone fruit, small fruit, grapes, and ornamentals. Other names: Delan, Delan-Col.
- Dithiocarbamates**. Organic sulfur fungicide derivatives of dithiocarbamic acid. See also Nabam, Thiram, Maneb, Zineb, Ziram.
- Ditranil**. See DCNA.
- DNC**. See Dinitro compounds.
- DNOC**. See Dinitro compounds.
- DMTT**, 3,5-dimethyl tetrahydro-1,3,4,2H-thiadiazine-2-thione, sold as Mylone (Union Carbide). A fumigant for soil fungi and nematodes, to be applied as a drench or as granules. See also Dazomet.
- Dodemorfe**. See Dodemorph (discontinued).
- Dodemorph** (BASF Aktiengesellschaft) (discontinued). N-cyclododecyl-2,6-dimethylmorpholinium acetate. Used for control of powdery mildew in ornamentals.
- Dodine**. Common name for *n*-dodecylguanidine acetate, sold as Cyprex (American Cyanamid; Keno Garb AB; Rhone-Poulenc Agrochimie; Shell Agrar Gmb H & Co. KG). Effective for foliage diseases of fruits, vegetables, and ornamentals, controlling scab on apple, pear, pecan, and cherry leaf spot. It also controls rose blackspot, but may be somewhat phytotoxic at normal dilution. Other names: AC 5223, Apadodine, Carpenne, Curitan, Melprex, Syllit, Venturol.
- Dogvadine**. See Dodine.
- Dojyopicrin**. See Chloropicrin.
- Dolochlor**. See Chloropicrin.
- Dowco 186**. See Du-Ter (discontinued by Dow Chemical Co.).
- Dofume MC-33** (discontinued by Dow Chemical). Methyl bromide 67%, chloropicrin 33%.
- Drawinol**. See Dinobuton.
- Drazoxolon** (ICI Arochemicals). 4-(2-chloro-phenylhydrazono)-3-methyl-5-isoxazolone. Effective against powdery mildews and rusts. Used for treatment against some seedling diseases. Other names: Ganocide, Mil-Col, SA Isan.
- DSE**. See Nabam.
- Duter**. See Du-Ter.
- Du-Ter** (Agtrol Chem. Products; Duphar B.V.; Hoechst AG; Wesley Industries, Inc.), triphenytin hydroxide. Used to control early and late blight on potatoes, leaf spot on sugar beets and peanuts, scab and several diseases on pecans, leaf spot and *Alternaria* blight on carrots. Other names: Brestanid, Duter, Haitin, Phenostat-H, Suzu H, TPTH, TPTOH, Triple Tin, Tubotin.
- Dwell**. See Koban.
- Dynone**. See Previcur.
- Dyrene** (Bayer AG; Mobay Corp., Agri. Chem. Div.). 2,4-dichloro-60-chloroanilino-*s*-triazine. Foliar fungicide, for control of anthracnose, *Botrytis*,

early and late blights of potato and tomato, and other vegetable diseases, strawberry leaf spot and scorch, dollar spot, melting-out and rust of turf, and leaf spot of gladiolus. Other names: Direx, Kemate, Triasyn.

Earthcide. See PCNB.

EL-273. See Triarimol (discontinued by Elanco Products Co.).

Elgetol 30 (A. H. Marks & Co., Ltd.; Pennwalt Holland B.V.; Tifa Ltd.). 4,6-dinitro-*o*-cresol. Used for apple scab control. Other names: Chemsect, DNOG, DNC, Nitrador, Selinon, Sinox, Trifocide, Trifrina.

Elvaron. See Euparen.

Endosan. See Morocide (discontinued in 1987 by Hoechst AG).

Equitdazin. See Carbendazin.

Eradex (Discontinued by Bayer AG). 2,3-quinoxalinedithiol cyclic trithio-carbonate. Used on ornamentals to kill spider mites and their eggs and also effective against powdery mildew.

Eraditon. See Eradex (discontinued).

Erazidon. See Eradex (discontinued).

ETCMTD. See Koban.

Ethazol. See Koban.

Ethylene dibromide. See under nematicides.

Etridiazole (Mallinckrodt, Inc.; Uniroyal Chem. Co.; United Agri-Products). 5-ethoxy-3-trichloromethyl-1,2,4-thiadiazole. Controls *Pythium* and some *Phytophthora* spp. Terra-Coat, Terraclor Super-X for seedling disease complex (*Fusarium*, *Rhizoctonia*, *Pythium*) of beans, sugar beets, and wheat; as a seed treatment or as in-furrow soil applications. Controls root rot (*Phytophthora cinnamoni*) of avocado; *Pythium* on strawberries; used on ornamentals, turf, vegetables. Other names: Aaterra, Dwell, ETCMTD, Ethazol, Koban, Pansoil, Phorate TSX, Truban. Combinations: Terra-Coat, Terraclor Super-X (Terraclor+Terrazole), Truban+methyl thiophanate (Banrot).

Etrimix. See Mancozeb.

Euparen (Bayer AG). *N'*-dichlorofluoromethylthio-*N,N*-dimethyl-*N'*-phenyl-sulfamide. Used for controlling *Botrytis* on strawberries, raspberries, currants, and grapes; rose mildew and other fungal diseases on orchard fruits, garden crops, and ornamentals. Other names: Bay 47531, Elvaron, Euparence, KUE 13032c.

Euparen M (Bayer AG). *N'*-dichlorofluoromethylthio-*N,N*-dimethyl-*N'*-(4-tolyl) sulfamide. Used for controlling scab on apples, *Botrytis* on strawberries, currants, and ornamentals. Other names: Bay 5712, Bay 49854, KUE 13183b.

Euparene. See Euparen.

Exotherm Termil (Diamond Shamrock). Tetrachloroisophthalonitrile. Used on greenhouse tomatoes and ornamentals for control of *Botrytis*. When heated it vaporizes to form a gas, which condenses, forming ultrafine particles deposited on plant surfaces. See also Bravo.

Fenaminosulf. See Lesan.

Fenarimol. See Rubigan.

Fenolovo acetate. See Brestan.

Fentin acetate. See Brestan.

Fentin hydroxide. See Du-Ter.

Ferbam (Pennwalt Holland B.C.; FMC Corp.; UCB Chem. Corp.). Common name for ferric dimethyl dithiocarbamate, sold in many pesticide combinations, the first organic fungicide to come into wide use. Used as a spray or as a 10% dust, often with sulfur, for damping-off of flower cuttings, apple rust and scab, brown rot of stone fruits, black rot of grapes, some *Botrytis* blights, anthracnose, downy mildews, leaf spots, including rose blackspot. It does not control powdery mildews. The black color is objectionable on some flowers, but there is little visible residue on foliage. Ferbam is of questionable compatibility with Paris green, TEPP, lime sulfur, lime, bordeaux mixture, and some fixed coppers. It is not highly toxic, with a tolerance of 7 ppm set for food crops, but may cause irritation if inhaled. Other names: Carbamate, Ferberk, Hexaferb, Knockmate, Trifungol.

Ferberk. See Ferbam.

Fermasan. See Thiram.

Fermate (discontinued by DuPont). See Ferbam.

Fermid 850. See Thiram.

Ferrous sulfate. Used to correct chlorosis from iron deficiency.

Filipin. Antibiotic that controls some seed-rot fungi and partially protects against some diseases of beans and tomatoes.

Flotation sulfur. See Sulfur.

FMC 9102. See Polyram-Combi.

Folcid. See Difolatan.

Folicur (Bayer AG; Mobay Corp.). α -[2-(4-chlorophenyl)ethyl]- α -(1, 1-dimethyl-ethyl)-1 H-1,2,4-triazole-1-ethanol. Effective against powdery mildew, rusts, leaf spots on fruits, vegetables, peanuts, and grasses grown for seed. Other name: Raxil.

Folosan. See PCNB.

Folpan. See Folpet.

Folpet. Common name for N-trichloromethyl-thiophthalimide, sold as Phaltan (Chevron). A protectant and eradicant fungicide for fruits, vegetables, and ornamentals controlling apple scab, cherry leaf spot, rose blackspot, with some effect on rose mildew, and other diseases. Compatible with most common pesticides but cannot be used with strong alkalis. Other names: Fungitrol II, Folpan, Thiophal.

Foltaf. See Difolatan.

Fonganil. See Fongarid.

Fongarid (Ciba-Geigy Ltd.). Methyl N-2,6-dimethylphenyl-N-furoyl (2)-alaninate. For soil-borne diseases caused by *Phytophthora* and *Pythium* spp. on ornamentals. Systemic properties. Other name: Fonganil, CGA 38140.

Fore (Rohm & Haas). A special formulation of Dithane M-45 developed for control of diseases of turf and certain ornamentals. Protects against dollar spot, red thread, copper spot, *Helminthosporium*, brown patch, rust, slime

mold, and Fusarium and Pythium blights of lawn grasses, also rose blackspot, chrysanthemum petal blight, gladiolus diseases.

Formaldehyde. Soil fumigant for damping-off and other diseases, not very efficient for nematodes; sold as Formalin, a 35–40% solution of a colorless gas in water and methanol. In preparing soil for flats, mix 3 tablespoons formalin with 1 cup of water and sprinkle over 1 bushel of soil; mix well. Fill flats; plant seed 24 hours later; then water. As a drench for fallow soil dilute 1 part formalin to 50 parts water and apply ½ to 1 gallon to each square foot of soil. As a treatment for potato scab, soak tubers for 2 hours in 1 pint formalin to 30 gallons water. Disinfest tools in a 5% solution. Do not use near living plants.

Formalin. See Formaldehyde.

Forturf. See Bravo.

Frucote, 2-aminobutane, or sec-butylamine. Used to control green or blue mold in lemons, oranges, and grapefruits and stem-end rot of oranges. Applied as dip, drench, or spray.

Fuberidazol. See Voronit.

Fuklasin. (discontinued name). See Ziram.

Fungiclor. See PCNB.

Funginex. See Triforine.

Fungi-Rhap. See Copper oxides.

Fungi-Rhap CU6; Liquid Copper Fungicide (CP Chem., Inc.), copper salts of fatty and rosin acids. Used to control leaf spots in carrots, peanuts, and sugar beets; bacterial spot in peppers and tomatoes; and melanose in citrus.

Fungitrol II. See Folpet.

Fungo 50 (Mallinckrodt, Inc.). Dimethyl 4,4-0-phenylenebis (3-thioallophanate). Used to control brown patch, Fusarium blight, dollar spot, red thread, stripe smut, and powdery mildews on turf.

Fusarex (ICI). 2,3,5,6-tetrachloronitrobenzene. Used to control dry rot in seed and ware potatoes.

Galben (Agrimont S.p.A). DL-alanine, N-(2,6-dimethylphenyl)-N (phenylacetyl)-methylester. Systemic fungicide controls Oomycetes including blue mold, late blight and downy mildew of potatoes, tomatoes, tobacco, hops, grapes, lettuce, peppers, onions, strawberries, sunflowers, soybeans, turf, flowers, ornamentals. Other names: Tairel, M9834.

Ganocide. See Drazoxolon.

Glyodex (discontinued by Agway, Inc.). glyodin 37.5% and dodine 22.5%. Used to control apple scab on apples and leaf spot on sour cherries.

Glyodin (discontinued by Agway, Inc.). 2-heptadecyl-2-imidazoline acetate, sold as Crag Fruit Fungicide 341 and Crag Glyodin. Protectant fungicide for control of scab and other apple diseases, cherry leaf spot, rose blackspot, and some other diseases of ornamentals. It may be slightly phytotoxic in certain mixtures and should not be used on solanaceous plants. Glyodin acts as a wetting agent, and the residue is invisible on foliage or fruit. The tolerance is 5 ppm. It is of questionable compatibility

- with benzene hexachloride, cryolite, oils, rotenone, pyrethrum, and some dinitro compounds.
- Glyoxide.** 2-heptadecyl imidazoline. Used on apples, sour cherries, and pears.
- Glyrophene.** See Iprodione.
- Granox PFM** (Chipman Chem., Inc.). Combination of maneb, captan, and molybdenum. Used as a protective seed treatment for peanuts to control seed-borne pathogens, including damping-off, seed decay organisms, and seedling blight.
- Guanidine.** See Dodine.
- Haipen.** See Difolatan.
- Haitin.** See Du-Ter.
- Harven.** See Dehydroacetic acid.
- Hexachlorophene** (discontinued in 1984 by Kalo Laboratories, Inc.). 2,7-methylene bis (3,4,6-trichlorophenol). Used on tomatoes, peppers, and cucumbers for fungus and bacterial diseases and as a soil fungicide against *Rhizoctonia*.
- Hexaferb.** See Ferbam.
- Hexasul.** See Sulfur.
- Hexathane.** See Zineb.
- Hexathir.** See Thiram.
- Hexazir.** See Ziram.
- Hizarocin.** See Actidione.
- Hoe 002873.** See Afugan.
- Hoe 017411.** See Carbendazin.
- Hoe 2784** (discontinued in 1987 by Hoechst AG). See Morocide.
- Hoe 2873** (discontinued in 1984 by Hoechst AG). See Afugan.
- Hoe 2989** (Hoechst AG). See Sicarol.
- Hoe 6052** (Hoechst AG). See Sicarol.
- Hoe 6053** (Hoechst AG). See Sicarol.
- Hoe 13764** (Hoechst AG). See Sicarol.
- Hoe 17411** (Hoechst AG). See Carbendazin.
- Homai** (Nippon Soda Co., Ltd.). Mixture of thiophanate-methyl and thiram. Used as a seed protectant on vegetables.
- Hot water,** used in disinfection of seeds, bulbs, and sometimes living plants to kill internal bacteria, fungi, or nematodes, the temperature and time of treatment varying with the plant.
- Hydroxydiphenyl.** See Ortho-Phenylphenol.
- Hydroxyisoxazole.** See Tachigaren.
- Hymexazol.** See Tachigaren.
- Iprodione** (Rhone-Poulenc Inc. Ag. Co.). 3-(3,5-dichlorophenyl)-N-(1-methylethyl) 2,4-dioxo-1-imidazolidinecarboxamide. Active on a broad spectrum of diseases on vines, grapes, fruits, berries, vegetables, ornamentals, flowers, turf, potatoes. Other names: 26019RP, Chipco 26019, Chipco 26019 Flo, Glycophene, LFA 2043, NRC 910, ROP500F, Rovral.
- Iscothane.** See Karathane.

Karamate. See Dithane M-45.

Karabation. See Metam-Sodium.

Karathane (Rohm & Haas). Common name dinocap, 2,4-dinitro-6-octyl-phenyl crotonate, and other nitrophenols. Of some value as a miticide and excellent for control of powdery mildews of apple and other fruits, vegetables, especially cucurbits that are sensitive to sulfur, roses, and other ornamentals. Karathane is also included in many dust mixtures sold for roses. It may be slightly phytotoxic above 85° F. Other names: Crotothane, Dinocap.

Kasugamycin (Hokko Chemical Industry Co., Ltd.). Kasugamycin hydrochloride. Used to control leaf mold of tomatoes, halo blight of beans, and apple scab.

Kasumin. See Kasugamycin.

Kayafume. See Methyl bromide.

K-Cop Liquid Agricultural Fungicide (Griffin Corp.). Aqueous solution containing 8% copper. Used on diseases of beans, cantaloupe, honeydews, muskmelon, watermelon, celery, cucumber, peanuts, peppers, potatoes, squash, and tomatoes.

Kemate. See Dyrene.

Kiwi Luster 277. See DCNA.

Knockmate. See Ferbam.

Koban (Mallinckrodt, Inc.; Uniroyal Chem. Co.; United Agri. Products). 5 ethoxy-3-trichloromethyl-1,2,3-thiadiazole. Used to control Pythium blight, cottony blight, grease spot, spot blight, and damping-off on turf. Other names: Aaterra, Dwell, ETCMTD, Ethazol, Pansoil, Phorate TSX, Truban.

Kobu. See PCNB.

Kobutol. See PCNB.

Kocide. See Copper hydroxide.

KOP 300. See Copper Sulfate, Basic.

Kroma-Clor. See Cadminate.

Kromad (Mallinckrodt, Inc.). Cadmium sebacate 5%, potassium chromate 5%, malachite green 1%, thiram 16%. Used to control brown patch, dollar spot, pink patch (red thread), copper spot, and leaf spot diseases of turf.

K-Tea Algaecide (Griffin Corp.). Copper (8%) as copper-triethanolamine complex. Controls planktonic and filamentous algae, hydrilla verticillata in golf course ornamental, fish and fire ponds, potable water reservoirs, freshwater lakes, and fish hatcheries.

Kue 13032c. See Euparen.

Kue 13183b. See Euparen M.

Kumulan (BASF AG). Sulphur and 5-nitro-benzene-1, 3-dicarboxylic acid bis (1-methylethyl) ester. Controls powdery mildew on apples and hops.

Kumulus S. See Sulfur.

Kypman. See Maneb.

Kypzin. See Zineb.

Labilite. See Maneb.

Larvacide. See Chloropicrin.

Lesan (Bayer AG). Sodium [4-(dimethylamino) phenyl]diazene sulfonate. Protects germinating seeds and seedlings in corn, beans, peas, spinach, cucumbers, and ornamentals.

LFA 910. See Iprodione.

LH 3012. See Antracol.

Lime, hydrated. Calcium hydroxide, used in preparing bordeaux mixture, and as a filler in pesticide dusts. Until recently considered relatively inert but may cause some of the dwarfing and hardening of bordeaux-sprayed plants.

Lime sulfur. Polysulfides formed by boiling together sulfur and milk of lime. The standard liquid has a specific gravity of 32 Baumé and the commercial product is far superior to the homemade. Lime sulfur dates back to 1851, when the head gardener, Grison, at Versailles, France, boiled together sulfur and lime for a vegetable fungicide called "Eau Grison." In 1886, this fungicide was used in California as a dormant spray for San Jose scale and later for peach leaf curl. A self-boiled lime sulfur made without heat was produced in 1908 as a summer spray for sensitive plants, but it was later replaced by wettable sulfurs for most fruit-spray programs. A dry form of lime sulfur was marketed about 1908.

Lime sulfur is still used as a dormant spray for fruits, roses, and some other plants for mildews, *Volutella* blight of boxwood, and other diseases. It should not be used at temperatures above 85° F.

Lime sulfur is compatible with nicotine sulfate and glyodin. It is incompatible with soaps, Paris green, cryolite, rotenone, pyrethrum, oils, dinitro compounds, benzene hexachloride, TEPP, bordeaux mixture, and fixed coppers. It is questionable with toxaphene, parathion, and dithiocarbamates.

Lonacol. See Zineb.

Lysol. Sometimes used for treatment of gladiolus corms. A 5% solution is used for dipping the cutting knife to prevent potato ring rot.

M 9834. See Galben.

Magnesium sulfate. Epsom salts, sometimes used as a safener and to correct nutrient deficiencies.

Magnetic 70. See Sulfur.

Malachite. See Copper carbonate.

Mancozeb. See Dithane M-45.

Maneb (BASF AG; Rhone Poulenc; Rohm & Haas). Common name for manganese ethylene bisdithiocarbamate. Used to control early and late blights of potato, tomato, celery, tomato anthracnose, leaf spots, downy mildews, purple blotch of onions, shothole of almond and peaches. Non-toxic to most plants, relatively safe to use, and useful for ornamentals because it leaves little visible residue. It controls anthracnose of violet and pansy, spot anthracnose of dogwood, rose blackspot, and *Cercospora* leafspot (but not powdery mildew), and some *Botrytis* blights. Other names; Akzo Chemie Maneb, BASF-Maneb Spritz-pulver, Dithane M-22,

- Dithane M-22 Special, Kypman 80, Manex 80, Maneba, Manesam, Manex, M-Diphar, Polyram M, Remasan Chloroble M, Rhodianebe, Sopranebe, Trimangol, Tubothane, Unicrop.
- Maneba.** See Maneb.
- Manebgan.** See Maneb.
- Manesan.** See Maneb.
- Manex.** See Maneb.
- Manex 80.** See Maneb.
- Manzate.** See Maneb.
- Manzate 200 Fungicide** (DuPont). Coordination product of zinc ion and manganese ethylene bisdithiocarbamate. Used as a protectant against a wide spectrum of diseases of fruits, vegetables, and nuts. Also used as a seed treatment on potatoes and peanuts.
- Manzeb.** See Dithane M-45.
- Maposol.** See Matham-Sodium.
- MBC.** Methyl 2-benzimidazolecarbamate. Common breakdown product of several fungicides, including benomyl, thiophanate-methyl, and other ethyl and methyl thiophanates. These contain the common characteristic that once a fungus has developed resistance to one, the fungus also possesses resistance to other fungicides of the same group (cross-resistance).
- MC 1053** (discontinued name). See Dinobuton.
- M-Diphar.** See Maneb.
- M-Dipher.** See Maneb.
- MEB 6447.** See Bayleton.
- MeBr.** See Methyl bromide.
- Melprex.** See Dodine.
- Meltatox.** See Dodemorph.
- Mepronil** (Kumiai Chem. Industry Co., Ltd.). 3'-isopropoxy-2-methylbenzanilide. Controls rusts of pear and chrysanthemum, and damping-off and southern blight of vegetables.
- Mercuran.** See Thiram.
- Merpan.** See Captan.
- Mertect** (Merck). See Thiabendazole.
- Metalaxyl** (Ciba Geigy Corp.). N-(2,6-Dimethylphenyl)-N-(methoxyacetyl)-alanine methyl ester. Controls soil-borne diseases caused by *Pythium* and *Phytophthora*, and foliar diseases caused by Phycomycetes (downy mildews). Other names: CGA 48988, Ridomil 2E, Ridamil 5G, Subdue 2E.
- Metam-Sodium** (BASF Aktiengesellschaft; ICI Plant Protection Division; Procida; Stauffer Chemical Co.). Sodium N-methyldithiocarbamate. General-purpose soil fumigant that is highly effective in control of weeds, weed seeds, nematodes, and soil fungi.
- Methanal.** See Formaldehyde.
- Metho-O-Gas.** See Methyl bromide.
- Methyl bromide** (Great Lakes Chem. Corp.). Soil fumigant, supplied under that name by a number of manufacturers. It is used in greenhouses because it is somewhat less toxic to plants than most other fumigants and for balled

or potted nursery stock in special fumigating chambers. As Dowfume MC-2, methyl bromide with 2% chloropicrin, it comes in cans with a special dispenser. The area to be treated is covered with plastic film, under which are evaporating pans with hoses leading to the edge of the cover. The dispenser is attached to each hose in turn to fill the pans, and then the edges of the cover are held down with soil. For small areas injections are made 10 inches apart. This material is very poisonous; follow all safety precautions. Other names: Brom-O-Gas, Brom-O-Gaz, Brom-O-Sol, Celfume, Kayafume, MeBr, Meth-O-Gas, Terr-O-Cide II, Terr-O-Gas.

Methylmetiram. See Basfungin.

Methyl thiophanate. See Fungo 50.

Metiram. See Polyram-Combi.

Metiram-Complex. See Polyram-Combi.

Mezene. See Ziram.

Mezineb. See Antracol.

MF-344. See Koban.

Micofume. See Dazomet.

Mil-Col. See Drazoxolon.

Milcurb (ICI Agrochemicals). 5-*n*-butyl-2-dimethylamino-4-hydroxy-6-methylpyrimidine. A systemic eradicator fungicide used for control of powdery mildew affecting cucumbers, melons, and certain ornamentals. One soil application may give protection for 6 weeks or more.

Mildex. (discontinued name). See Karathane.

Mildothane. See Thiophanate-Methyl.

Miltox (Sandoz, Ltd.). Zineb, copper oxychloride. Controls downy mildew (*Plasmopara*) and Brenner disease (*Pseudopeziza*) in grapes and other diseases in most crops.

Monceren (Bayer AG; Mobay Corp.). N-[(4-chlorophenyl)-methyl]-N-cyclopentyl-N'-phenylurea. For *Rhizoctonia solani* caused diseases in potatoes, rice, sugar beets, and ornamentals.

Monox. See Polynox.

Morestan (Bayer AG; Mobay Corp.). 6-methyl-2,3-quinoxalinedithio cyclic carbonate. Insecticide, miticide also effective for powdery mildew on apple and other crops; may cause some fruit spotting.

Morocide (Hoechst AG). 2-*sec*-butyl-4,6-dinitrophenyl-3-methyl-2-butenolate. A contact miticide with ovicidal action and fungicide for control of powdery mildews on apples, pears, plums, prunes, almonds, and walnuts.

Morroid (discontinued name by Hoechst AG in 1987). See Morocide.

Mycodifol. See Difolatan.

Mylone. See Dazomet.

Nabac 25 EC (discontinued in 1984 by Kalo Laboratories, Inc.). 2,2-methylenebis (3,4,6-trichlorophenol). Used as a broad-spectrum foliar fungicide and bactericide.

Nabam (Rhone-Poulenc Agrochimie). Common name for disodium ethylene-1,2-bisdithiocarbamate, sold as Dithane D-14, a liquid, very useful for some vegetable and flower diseases, especially tomato and potato blights,

- azalea flower blight. It is usually used with zinc sulfate to form zineb in the spray tank. It controls some root-rotting fungi and enhances the effect of a nematicide by stimulating hatching of eggs of root-knot and some cyst nematodes. Other names: Chem Bam, DSE, Nabasan, Parzate, Spring-Bak.
- Nabasam.** See Nabam.
- Naramycin.** See Actidione.
- Natriphene** (Natriphene Co.). Sodium salt of *o*-hydroxyphenyl. Use for damping-off and other diseases of ornamentals, especially orchids, and of some merit for powdery mildew on rose.
- Nemacur.** See Nematicides section.
- Nemisor.** See Dithane M-45.
- Nia 9044** (FMC Corp.). See Morocide.
- Nia 9102** (name discontinued by FMC Corp.). See Polyram-Combi.
- Niacide** (discontinued by FMC Corp.). Mixture of manganous dimethyl dithiocarbamate and mercaptobenzothiazole. Apple and pear foliage spray for scab and summer diseases.
- Nimrod.** See Bupirimate.
- Nitrador.** See Dinitro compounds.
- Nomersan.** See Thiram.
- Nordox SD-45.** See Copper oxides.
- Nordox SD-50.** See Copper oxides.
- Nu-Z.** See Zinc sulfate.
- Ofurace** (Chevron Chem. Co, Ortho Agri. Chem. Div.). 2-chloro-N-(2,6-dimethylphenyl)-N-(tetrahydro-2-oxo-3-furanyl) acetamide. Systemic action both acropetal and basipetal. For Phycomycete plant pathogens, notably downy mildew of grapes, hops and lettuce, late blight of potato, tomato, and Phytophthora crown and root rots of safflower and tobacco.
- Oleocuvire.** See Copper oxides.
- Oleo Nordox.** See Copper oxides.
- OM-2424** (discontinued name). See Etridiazole.
- Ornalin.** See Vinclozolin.
- Orthocide.** See Captan.
- Ortho-phenylphenol** (Dow Chemical Co.). 2-phenylphenol; or ortho-phenylphenol. Used as postharvest treatment in wax to retard spoilage of fruits and vegetables in transit to market.
- Orthoxenol** (discontinued name). See Ortho-phenylphenol.
- Oxadixyl** (Sandoz Ltd., Agro Div.). 2-methoxy-N-(2-oxo-1,3 oxazolidinyl) acet-2',6'-xylidide. Preventive and curative activity against many Oomycetes on grape vines, potatoes, vegetables, ornamentals, and seed treatments. Other names: Pulsan, Recoil, Ripost, Sandofan, Wakil.
- Oxycarboxin.** See Plantvax.
- Oxyquinoline sulfate** (Probelte, S.A.). 8-hydroxyquinoline sulfate. Used as a drench to control root-rotting fungi such as *Rhizoctonia solani*. Also used for treating citrus fruits for stem end rot and green mold, orchids for black mold, and carnations for wilt. Other name: Chinosol.

Oxythioquinox. See Morestan.

Pallinal (BASF AG). tris[ammine[ethylene-bis (dithiocarbamate)] zinc (2+)] [tetrahydro-1,2,4,7-dithia-diazocine-3,8 dithione], polymer, 5-nitro-benzene-1,3-dicarboxylic acid bis (1-methylethyl) ester. Controls powdery mildew on apples and apple scab.

Pansoil. See Koban.

Parinol. See Parnon.

Parnon (discontinued by Elanco). *a,a*-bis (4-chlorophenyl)-3-pyridylmethanol, for powdery mildews of rose, fruits, and vegetables; nontoxic to ornamental plants.

Parzate. See Nabam.

Parzate C. See Zineb.

PCNB (Uniroyal Chem. Co.). Pentachloronitrobenzene, excellent soil fungicide that may be used around living plants. It controls various root, stem, and crown rots of vegetables and ornamentals, is available as a dust, 75% wettable powder, and an emulsifiable concentrate. For club root of crucifers, work dust into soil before planting and use in liquid form for transplants. Mix into soil before planting for southern blight of peanuts but apply at transplanting for peppers and tomatoes. For camellia blight, apply to soil under bushes in early winter. Use as a soil dust or drench for stem rot of carnation, poinsettia, African violet, snapdragon, and other ornamentals. Use the manufacturer's dosage chart for different formulations and situations. Other names: Avicol, Botrilex, Earthcide, Folosan, Kobu, Kobutol, Pentagen, Quintox, Terraclor, Tilcarex, Tri-PCNB.

Penconazole (Ciba-Geigy Corp.). 1-[2-(2,4-dichlorophenyl)-*n*-pentyl]-1*H*-1,2,4-triazole. Systemic fungicide for protective, curative, and eradicated use against powdery mildews, pome fruit scab, and other pathogenic ascomycetes, basidiomycetes, and deuteromycetes. For use in grapes, deciduous fruits, vegetables and ornamentals. Other names: Award, Topas, Topaz, Topaze, CGA-71818.

Penncozeb. See Dithane M-45.

Pentagen. See PCNB.

Perecot (discontinued name). See Copper oxides.

Perenox (discontinued by ICI Plant Protection Division). Cuprono oxide. Used to control many common leaf and fruit diseases of tomato, potato, celery, peach, banana, cocoa, tea, and citrus.

PETD (discontinued name). See Polyram-Combi.

Phaltan. See Folpet.

Phenamiphos (discontinued name). See Nemacur.

Phenostat-H. See Du-Ter.

Phentinacetate. See Brestan.

Phenylphenol. See Ortho-phenylphenol.

Phleomycin. Isolated from *Streptomyces* by Japanese workers. Used to control rust on snap beans.

Phorate TSK. See Koban.

Phygon (discontinued by Uniroyal). See Dichlone.

Phyto-Bordeaux Super CU. See Copper Sulfate, Basic.

Phytomycin. See Streptomycin.

Phyton-27 (Source Technology Biologicals, Inc.). Tannate complex of micro cupric ammonium formate. Broad spectrum for tree injection of Dutch elm disease prevention and control. Other applications by foliar spray and soil drench.

Pic-Clor. See Chloropicrin.

Picfume. See Chloropicrin.

Piperalin (Elanco Products Co., Div. Eli Lilly and Co.). Common name for 3-(2-methylpiperidino) propyl 3,4-dichlorobenzoate. Sold as Pipron. For powdery mildew on rose and other ornamentals. The liquid form leaves less visible residue than the wettable powder.

Pipron. See Piperalin.

PKhNB. See PCNB.

Plantomycin. See Streptomycin.

Plantvax (Uniroyal). 2,3-dihydro-5-carboxanilido-6-methyl-1,4-oxathiin-4,4-dioxide, systemic fungicide, effective in controlling rust diseases.

Polycar MZ. See Dithane M-45.

Polycar S. See Dithane M-45.

Polynox (discontinued by Nihon Nohyaku Co., Ltd.). Mixture of Polyoxin and Monox, zinc dimethyl dithiocarbamate bis (dimethyl) dithiocarbamoyl ethylenediamine. Used against diseases of apple and pear.

Polyoxin (Kaken Pharmaceutical Co., Ltd.). Antibiotic fungicide. Used to control *Alternaria* leafspot of apple, black spot of pear, gray mold and leaf mold of tomato, *Sclerotinia* rot, stem rot, leaf blight and leaf spot of cucumber, *Alternaria* leaf spot of welsh onion, gray mold and powdery mildew of strawberry, and leaf blight of carrot. Other names: Polyoxin AB, Polyoxin B.

Polyoxin AB. See Polyoxin.

Polyoxin B. See Polyoxin.

Polyram-Combi (BASF Aktiengesellschaft; FMC Corp.). Coprecipitation of zinc ammonia ethylene-bis-dithiocarbamate and polyethylene-bis-thiocarbamoyl disulfide. Used to control diseases of apples, asparagus, peanuts, pecans, potatoes, sweet corn, and tobacco; also scab and cedar apple rust on apple and rose blackspot. Other names: Metiram, Metiram-Complex.

Polyram M. See Maneb.

Polyram-Ultra. See Thiram.

Polyram Z. See Zineb.

Pomarsol Forte. See Thiram.

Pomarsol Z Forte. See Ziram.

Potassium permanganate. Occasionally used as a disinfectant for bulbs and rhizomes and for dipping grafting knives and other tools (1 ounce to 2 gallons of water). Applied to citrus trunks, 1 teaspoon to 1 pint of water, after cleaning scaly bark wounds.

- PP-588. See Bupirimate.
- PP-675. See Milcurb.
- PP-781. See Drazoxolon.
- Previcur** (discontinued by NOR-AM Agricultural Products, Inc.; Schering AG). ethyl-N-(3-dimethyl-amino-propyl)-thiol-carbamate hydrochloride. Used to control *Pythium*, *Peronospora*, *Bremia*, *Phytophthora*, and other Peronosporales; emergence promoting, and is partially systemic.
- Prezervit**. See Dazomet.
- Propineb**. See Antracol.
- Prothiocarb**. See Previcur.
- PTF** (discontinued name). See Polyram.
- Pyracarbolid**. See Sicarol.
- Pyrazophos**. See Afugan.
- Quinomethionate**. See Morestan.
- Quintox**. See PCNB.
- Quintozene**. See PCNB.
- Raxil**. See Folicur.
- Readex** (discontinued by Bayer AG). See Eradex.
- Remasan Chloroble M**. See Maneb.
- Resisan**. See DCNA.
- Rhodianebe**. See Maneb.
- Ridomil**. See Metalaxyl.
- Ridomil MZ**. See Metalaxyl.
- Ridomil MZ58**. See Metalaxyl.
- Ridomil MZ72**. See Metalaxyl.
- Ridomil Plus**. See Metalaxyl.
- Rizolex** (Sumitomo Chem. Co.). 0-2, 6-dichloro-4-methylphenyl 0,0-dimethyl phosphorothioate. For control of soil-borne diseases caused by *Rhizoctonia*, *Sclerotium* and *Typhula* on potatoes, sugar beets, cotton, peanuts, vegetables, cereals, ornamentals, turf by soil and seed treatment. Other name: S-3349.
- Ronilan**. See Vinclozolin.
- Rop 500F**. See Iprodione.
- Rovral**. See Iprodione.
- RPH**. See Thiabendazole.
- Rubigan** (Elanco Products Co., Div. of Eli Lilly and Co.). 3-(2-chlorophenyl)-3-(4-chlorophenyl)-5-pyrimidine-methanol. Provides protectant, curative, and eradicant activity against certain diseases such as powdery mildew, scab and rust of apple, dollar spot, large brown patch, fusarium blight and snow mold of turf, powdery mildew of roses.
- S-3349**. See Rizolex.
- SAI San**. See Drazoxolon.
- Salsan**. See Drazoxolon.
- Sanspor** (ICI Agrochemicals; Crystal Chem. Inter-America). Used to control potato blight, especially tuber blight. Other names: Criafolatan, Foltaf, Haispen, Mycodifol.

Saprol. See Triforine.

Selinon. See Dinitro compounds.

SF-6505. See Tachigaren.

Sicarol (discontinued in 1984 by Hoechst AG). 2-methyl-5,6-dihydro-4-H-pyran-3-carboxylic acid anilide. Used for seed and foliar treatment to control rusts and smuts on ornamentals, coffee, tea, and vegetables.

Sinox. See Dinitro compounds.

SMDC. See Metam-Sodium.

SN 41703. See Previcur.

Sodium dehydroacetate. See Dehydroacetic acid.

Sodium hypochlorite. Recommended as a disinfectant for pruning tools for fire blight control to replace dangerous mercurials. Dipping for 2 seconds in 10% solution kills bacteria. Can be purchased as Chlorox.

Sodium methylthiocarbamate. See Metam-Sodium.

Sofril. See Sulfur.

Sopranebe. See Maneb.

Spergon. See Chloranil.

Spotrete. See Thiram.

Spotrete-F. See Thiram.

Spotrete-WP 75. See Thiram.

Spring-Bak. See Nabam.

SR-406. See Captan.

SS 1451. See Eradex.

SS 2074. See Morestan.

Streptomycin (MSD Agvet, Div. of Merck Co., Inc.; Pfizer Inc. Chem. Div.).

Antibiotic formulated as a sulfate or a nitrate, effective for many bacterial and fungus diseases. As Agrimycin 17 (Pfizer) it is rather widely used, applied at blossom stage, for control of fire blight of apple and pear. Streptomycin is also used for walnut blight; bacterial leaf spots of tomato, pepper, philodendron; chrysanthemum bacterial blight; stem rot of stock; bean and celery blights; downy mildew, wilt, and angular leaf spot of cucurbits; crown gall on rose and cherry. Dusts are formulated with pyrophyllites, hydrated lime, sulfur, or calcium or magnesium carbonates as carriers. Phytotoxicity shows as a chlorotic flecking, sometimes stunting. Recent research indicates that spraying at night, when humidity is high, increases the absorption of streptomycin for fire blight control. Other names: Agri-Mycin 17, Agri-Strep, Plantomycin, Anisomycin, Phytomycin.

Subdue 2E. See Metalaxyl.

Sul-Cide. See Sulfur.

Sulfacop. See Copper sulfate.

Sulfur (Agtrol Chem. Products; BASF AG; Chem. Enterprises, Inc.; FMC Agri Chem.; Hoechst AG; ICI Americas Inc.). The oldest known fungicide, antedating written history, and somewhat effective as a miticide. In dust form, the particles should be fine enough to go through a 325-mesh screen.

Flowers of sulfur, small crystals produced by sublimation, are not fine enough.

Wettable sulfurs have wetting agents added for ready mixing with water for sprays. Flotation sulfurs are by-products of the manufacture of fuel gas from coal, so finely divided that they are almost colloidal. Micronized sulfurs also have particles approaching colloidal size. Sulfur sprays and dusts are effective in control of powdery mildews, rusts, apple scab, brown rot of stone fruits, rose blackspot, and other diseases. They are compatible with many other fungicides (having a synergistic effect with copper) and most insecticides, but should never be used with, or within a month of, oil sprays. Sulfur is of questionable compatibility with dinitro compounds and parathion. It is exempt from tolerance.

Wettable sulfurs and sulfur dusts are safer than lime sulfur at high temperatures, but should be used with caution above 85°F. They are not safe on many varieties of cucurbits, decreasing yield of squash and melon except in sulfur-resistant varieties. Other names: Brimstone, Sul-Cide.

Sulkol. See Sulfur.

Sultricap. See Copper Sulfate, Basic.

Sup'r Flo (discontinued by Rhone-Poulenc). See Maneb.

Super X Macclesfield. See Bordeaux mixture.

Suzu. See Brestan.

Suzu H. See Du-Ter.

Syllit. See Dodine.

Tachigaren (Sankyo Co., Ltd.). 3-hydroxy-5-methylisoxazole. Used to control fungi causing damping-off, such as *Fusarium*, *Aphanomyces*, *Corticium*, and *Pythium*.

Taifen. See Antracol.

Tairel. See Galben.

Talan. See Dinobuton.

TBCS-53. See Copper Sulfate, Basic.

TBZ. See Thiabendazole.

Tecto. See Thiabendazole.

Tecto RPH. See Thiabendazole.

Telone C. See Chloropicrin.

Tennessee Brand Tri-Basic Copper Sulfate 53WP. See Copper Sulfate, Basic.

Termil. Formulation of Daconil. A thermal dust effective for Botrytis flower spotting on orchids, geraniums, and other ornamentals. See also Daconil.

Terraclor. See PCNB.

Terraclor Super X. See Terrazole.

Terra-Coat. See Terrazole.

Terrazole (Mallinkroott, Inc.; Uniroyal Chem. Co., Inc.; United Agri Products). 5-ethoxy-3-trichloromethyl-1,2,4 thiadiazole. Used to control *Pythium* at low rates. Other names: Aaterra, Dwell, ETC MTD, Ethazol, Koban, Pansoil, Phorate TSX, Truban.

- Terr-O-Cide** (discontinued by Great Lakes Chemical Corp.). Combinations of ethylene dibromide and chloropicrin, or 1,3-dichloropropene, 1,2-dichloropropane, and related chlorinated hydrocarbons with chloropicrin. Used to control nematodes and fungi in soils.
- Terr-O-Gas** (Great Lakes Chemical Corp.). Various percentage proportions of methyl bromide and chloropicrin. Used to control nematodes and fungi in soils.
- Tersan 75** (discontinued by DuPont Co.). See Thiram.
- Tersan 1991**. See Benomyl.
- Tersan SP** (discontinued by DuPont Co.). See Chloroneb.
- Tetrapom**. See Thiram.
- Thiabendazole** (Merck & Co., Inc.). 2-(4'-thiazolyl)-benzimidazole. Used to control green mold, blue mold, and stem end rot of citrus fruits; *Cercospora* leaf spot on sugar beets; brown patch, *Fusarium* patch, and dollar spot on turf; *Fusarium* basal rot, and *Penicillium* blue mold on ornamental bulbs and corms; brown rot on bananas; blue mold rot, bull's eye rot, and gray mold on apples and pears; black rot, scurf, and foot rot on sweet potatoes; *Fusarium* storage rot on Hubbard squash. Other names: Apl-Luster, Arbotect, Mertect, TBZ, Tecto, Tecto RPH, Thibenzole.
- Thibenzole**. See Thiabendazole.
- Thimer**. See Thiram.
- Thioknock**. See Thiram.
- Thiolux**. See Sulfur.
- Thioneb**. See Polyram-Combi.
- Thion 80**. See Sulfur.
- Thion 95**. See Sulfur.
- Thiophal**. See Phaltan.
- Thiophan**. See Thiophanate-Methyl.
- Thiophanate** (W. A. Cleary Chem. Corp.; Nippon Soda Co., Ltd.). 1,2-bis(3-ethoxycarbonyl-2-thioureido) benzene, or diethyl (1,2-phenylene) bis-(iminocarboxothioyl) (carbamate), active ingredient Topsin. Used to control diseases of turf as a systemic fungicide. Other names: Cercobin, Topsin E.
- Thiophanate-Methyl** (Nippon Soda Co., Ltd.; Pennwalt Corp.). Dimethyl (1,2-phenylene) bis-(iminocarboxo-thioyl) bis-(carbamate), also known as dimethyl 4,4'-*o*-phenylenebis(3-thioallophanate). Technical at least 96% active ingredient. Used as a systemic fungicide on a broad spectrum of diseases in vegetables, fruit, and turf. Other names: Cercobin M, Mildothane, Thiophan, Topsin M 70W, Topsin M 4.5E, Topsin Turf and Ornamentals.
- Thioquinox** (discontinued by Bayer AG). See Eradex.
- Thiotex**. See Thiram.
- Thiovit**. See Sulfur.
- Thiram** (W. A. Cleary; Pennwalt Corp.; UCB Chemicals Corp.; R.T. Vanderbilt Co., Inc.). bis-(dimethylthio-carbamoyl) disulfide; or tetramethylthiurani disulfide. Used as a seed protectant against seed decays and damping-off and also seedling blights. Controls certain fungus diseases of apples, peaches,

- strawberries, celery, and tomatoes. Used also as a fungicide on turf to control large brown patch and dollar spot. Other names: AAtack, Aules, Chipco Thiram 75, Fermide 850, Fernasan, Hexathir, Mercuram, Nomersam, Polyam Ultra, Pomarsol Forte, Spotrete-F, Spotrete WP75, Tetrapom, Thimer, Thioknock, Thiotex, Thiram Tech, Thiramad, Thirasan, Thiuramin, Tirampa, Trametan, Tripomol, Tuads.
- Thirama D.** See Thiram.
- Thiram Tech.** See Thiram.
- Thirasan.** See Thiram.
- Thiuramin.** See Thiram.
- Thylate** (discontinued by DuPont Co.). See Thiram.
- Thynon** (discontinued). See Dithane.
- Tiazin.** See Zineb.
- Tiezene.** See Zineb.
- Tilcarex.** See PCNB.
- Tineston.** See Triphenyltin acetate.
- Tinnate** (Nihon Nohyaku Co., Ltd.). Triphenyltin chloride 10%. Used to control late blight of potato.
- Tirampa.** See Thiram.
- TMTDS.** See Thiram.
- TNCS 53.** See Copper Sulfate, Basic.
- Tobaz** (discontinued by Merck Chemical Div.). See Thiabendazole.
- Tolyfluanid.** See Euparen M.
- Topas.** See Penconazole.
- Topaz.** See Penconazole.
- Topaze.** See Penconazole.
- Topsin E.** See Thiophanate.
- Topsin Turf and Ornamentals.** See Thiophanate-Methyl.
- Topsin wettable powder.** Thiophanate 50%. A broad-spectrum fungicide with preventive, curative, and systemic properties.
- Topsin M.** See Thiophanate-Methyl.
- TPTA.** See Brestan.
- TPTH.** See Du-Ter.
- TPTOH.** See Du-Ter.
- Trametan.** See Thiram.
- Triadimefon.** See Bayleton.
- Triarimol** (discontinued by Elanco Products Co.). Mildew fungicide.
- Triasyn.** See Dyrene.
- Tribasic copper sulfate.** See Copper Sulfate, Basic.
- Tricarbamix.** See Ziram.
- Tricarbasul** (discontinued by Pennwalt Holland B.V.). Co-manufactured ethylene bis-dithiocarbamate containing zinc and manganese ions and wettable sulfur. Used for control of downy mildew and powdery mildew of apples and cucurbits.
- Tri-Clor.** See Chloropicrin.

- Tri-Con.** See Chloropicrin.
- Tricop.** See Copper Sulfate, Basic.
- Trifocide.** See Dinitro compounds.
- Triforine** (Em Industries; Shell Agrar GMBH & Co. KG). N,N'-(1,4-piperazinediyl-(2,2,2-trichloroethylidene))-bis (formamide). Used as a systemic fungicide to control powdery mildew, scab, rust, and other diseases of ornamentals, fruits, and vegetables.
- Trifrina.** See Dinitro compounds.
- Trifuncit.** See Dithiocarbamates.
- Trifungol.** See Ferbam.
- Trimangol.** See Maneb.
- Trimastan** (Pennwalt Holland B.V.). Mixture of maneb and triphenyltin acetate. Used to control potato blight and *Cercospora* diseases of sugar beet and celery.
- Trimaton.** See Metam-Sodium.
- Tri-Milttox** (Sandoz Ltd.). Mancozeb + 3 copper salts (copper oxychloride, copper sulfate, copper carbonate). For control of downy mildews (*Phytophthora*, *Plasmopara*) and other diseases in grapes, potatoes, tomatoes, and most other crops.
- Triofterol.** See Zineb.
- Trioneb.** See Polyram-Combi.
- Tri-PCNB.** See PCNB.
- Triphenyltin acetate.** See Brestan.
- Triphenyltin chloride.** See Tinnate.
- Triphenyltin hydroxide.** See Du-Ter.
- Triple Tin.** See Du-Ter.
- Tripomol.** See Thiram.
- Triquintam** (discontinued by Pennwalt Holland B.V.). Mixture of PCNB and thiram. Used for soil disinfestation of sclerotiae-forming fungi.
- Triscabol.** See Ziram.
- Tritisan.** See PCNB.
- Tritofterol.** See Zineb.
- Trizone** (Dow Chemical). Methyl bromide, chloropicrin, 3-bromoproparyl bromide, and related compounds. A nematicide to be used with caution. See also Methyl bromide.
- Truban** (Sierra Chem. Co.). 5 ethoxy-3-trichloromethyl-1,2,4-thiadiazole. Used to control *Pythium* and *Phytophthora*.
- Tsitrex.** See Dodine.
- Tuads.** See Thiram.
- Tubothane.** See Maneb.
- Tubotin.** See Du-Ter.
- Turfcide.** See Bravo.
- Tuzet.** See Urbacid.
- UC 19786.** See Dinobuton.
- Unicrop Maneb.** See Maneb.

- Urbacid** (discontinued by Bayer AG). bis(dimethylthio-carbamoylthio) methyl arsine. Used to control coffee diseases and apple scab.
- Validacin** (Takeda Chemical Industries, Ltd.). N-(1 S)-(1,46/5)-3-hydroxy-methyl-4,5,6-trihydroxy-2-cyclohexenyl) (O-beta-D-glucopyranosyl-(-3-(15)-(1,2,4/3,5)-2,3,4-trihydroxy-5-hydroxy-methylcyclohexyl) amine. Used to control damping-off of vegetables caused by *Rhizoctonia* and black scurf of potatoes.
- Validamycin A**. See Validacin.
- Vancide-TM Flowable** (discontinued by R. T. Vanderbilt Co.). See Thiram.
- Vancide TM-95** (discontinued by R. T. Vanderbilt Co.). See Thiram.
- Vapam**. See Metam-Sodium.
- Vencedor**. See Copper sulfate; Copper Sulfate, Basic.
- Venturrol**. See Dodine.
- Vi-Cad**. See Caddy.
- Vinclozolin** (BASF AG; Sierra Chem. Co.). 3-(3,5 dichlorophenyl)-5-ethenyl-5-methyl-2,4-oxazolidinedione. For control of *Botrytis* spp., *Sclerotinia* spp., *Monilia* spp. in grapes, strawberry, rape, soft fruits, hops, vegetables and ornamentals, also turf diseases. Other names: Ronilan, Ornalin, Vorlan.
- Vitavax** (Uniroyal). 2,3-dihydro-5-carboxanilido-6-methyl 1,4-oxathiin, systemic fungicide used for damping-off rusts and seed treatment.
- Vondcaptan**. See Captan.
- Vondodine**. See Dodine.
- Vondozeb Plus**. See Dithane M-45.
- Vorlan**. See Vinclozolin.
- Voronit** (discontinued). Mixture of 2 (2'-furyl)-benzimidazole (I) and hexachlorobenzene (II). Used as a seed dressing with special action against *Fusarium*.
- VPM**. See Metam-Sodium.
- Yellow Cuproside**. See Copper oxides.
- Z-C Spray** (discontinued by FMC Corp.). See Ziram.
- Zebtox**. See Zineb.
- Zerlate**. See Ziram.
- Zidan** (discontinued by Makhteshim-Agan). See Zineb.
- Ziman-Dithane**. See Dithane M-45.
- Zincmate**. See Ziram.
- Zinc Metiram**. See Polyram-Combi.
- Zinc sulfate** (discontinued by Cities Service Co.). Used with Dithane D-14 to form zineb and also to control zinc deficiency diseases such as little-leaf or mottle-leaf.
- Zineb** (Bayer AG; Drexel Chem. Co.; Pennwalt Holan B.V.; Rhone-Poulenc Agrochimie), common name for zinc ethylene bisdithiocarbamate, available as Dithane Z-78 and as Parzate, also in many pesticide mixtures. Effective for azalea petal blight, Botrytis blight of peony, tulip, rose blackspot, snapdragon rust, potato and tomato blights, downy (but not powdery) mildews, anthracnose diseases, citrus fruit russet, strawberry root rot. It is

- used some as a blossom spray for fire blight and for other fruit diseases. The tolerance is 7 ppm for most food crops. Other names: Aspor, Chem Zineb, Devizeb, Dipher, Hexathane, Kypzin, Lonccol, Parzate, Parzate C, Polyram Z, Tiezene, Tritoforol, Zebtox, Zineb 75, Zineb 75%, Zineb 75WP, Zinosan.
- Zineb 75%.** See Zineb.
- Zineb 75WP.** See Zineb.
- Zinosan.** See Zineb.
- Ziram** (FMC Agri. Chem. Group; Pennwalt Corp.; Rhone-Poulenc Agrochemie; UCB Chem. Corp.; R.T. Vanderbilt Co., Inc.). Common name for zinc dimethyl dithiocarbamate, sold as Zerlate or Karbam White. Effective for some vegetable blights and leaf spots, some fruit diseases.
- Zirbeck.** See Ziram.
- Ziride.** See Ziram.
- Zitox.** See Ziram.

BACTERICIDES

- Agri.-Mycin 17** (Pfizer Inc., Chem. Div.). Streptomycin sulfate, for control of bacterial plant diseases.
- Agri.-Strep.** See Strystomycin in Fungicides section.
- Agritol** (discontinued by Merck & Co.). *Bacillus thuringiensis*.
- Agrox Strep** (discontinued by Chipman Chem., Inc.). Combination bactericide, insecticide, and fungicide, seed treatment of beans where halo blight is a problem. Registered only in Michigan.
- Bacticin** (discontinued by TUCO Div., Upjohn). Antibiotic bactericide for eradicating crown gall on fruits, rose, and other ornamentals, and for treating olive knot.
- Barquat Compounds** (Lonza, Inc.). Quarternary ammonium compounds. Germicidal effectiveness against a wide variety of microorganisms in antiseptics, germicides, algicides, deodorants, and detergent-sanitizers.
- Barquat MB-50.** See Benzalkonium chloride.
- Barquat MB-80.** See Benzalkonium chloride.
- Bayclean.** See Dimanin A.
- Benzalkonium Chloride** (Lonza Inc.). Alkyl dimethyl benzylammonium chloride. Bactericide, fungicide.
- Bromofume.** See Ethylene dibromide in Nematicides section.
- Brom-O-Gas.** See Methyl bromide in Nematicides section.
- Bromoethane.** See Methyl bromide in Nematicides section.
- Brom-O-Sol** (Great Lakes Chemical Corp.). Contains methyl bromide 68.6%, chloropicrin 1.4%, organic solvent 30%. Used to control soil-borne diseases, nematodes, and insects. Growth difficulty may be experienced on carnations, holly, snapdragons, and multiflora rose. Apply at least 18 inches from plants to be maintained.
- Bronopol** (Schering Ag.). Used as a bactericide and bacteriostat against *Xanthomonas malvacearum* and *Erwinia amylovora*.

- Chinosol.** See Fungicides.
- Copper hydroxide.** See Fungicides.
- Copper Sulfate, Basic.** Contains a minimum 53% copper (metallic basis). Used widely to control citrus diseases, bacterial and fungus diseases of tomatoes and peppers as well as fruit, vegetables, and ornamentals. See also Fungicides.
- Cryptonol** (discontinued by Duphar-Midox Ltd., England). Potassium hydroxyquinoline sulfate. Used as a soil drench, dip, or spray for control of fungal and bacterial diseases or a glass-house disinfectant.
- Dimanin A** (Bayer AG). Alkyldimethylbenzylammonium chloride. Algicide, bactericide. Other name: Bayclean.
- Dimanin C** (Bayer AG). Sodium dichloroisocyanurate. Algicide, bactericide, viricide.
- Gallex** (Ag Bio Chem, Inc.). 2,4-Xylenol, meta-Cresol, and penetrants. Crown gall eradicant.
- Galltrol-A** (Ag Bio Chem, Inc.). *Agrobacterium radiobacter* (strain 84). Biological control; ecological preventative.
- Hexachlorophene** (discontinued by Kalo Laboratories, Inc.). 2,7-methylene bis-(3,4,6-trichloro-phenol). Used on tomatoes, peppers, and cucumbers for fungus and bacterial diseases and as a soil fungicide against *Rhizoctonia*.
- Kasugamycin** (Hokko Chemical Industry Co., Ltd.). Kasugamycin hydrochloride. Used to control leaf mold of tomatoes, halo blight of beans, and apple scab.
- Mycoshield** (Pfizer Inc.). Contains 17% oxytetracycline. Antibacterial, antibiotic.
- Nabac 25 EC** (discontinued by Kalo Laboratories, Inc.). 2,2-methylenebis (3,4,6-trichlorophenol). Used as a broad-spectrum foliar fungicide and bactericide.
- Phytomycin** (Olin Mathieson). Streptomycin nitrate, promising antibiotic for lima bean downy mildew, tomato blight. See Streptomycin in Fungicides section.
- Phyton 27** (Technology Biologicals, Inc.). Tannate complex of pirro cupric ammonium formate. Systemic fungicide, bactericide. Other name: Copper complex.
- TBCS-53.** See Copper Sulfate, Basic in Fungicides section.
- TBNS-53.** See Copper Sulfate, Basic in Fungicides section.
- Tribasic Copper Sulfate.** See Copper Sulfate, Basic in Fungicides section.
- Zinc Sulfate, Basic** (discontinued in 1985 by Woolfolk Chemical Works, Inc.). $ZnSO_4 - H_2O$ (the monohydrate is used in agriculture). Used as bactericide and nutritional spray on peaches.

NEMATICIDES

- A7 Vapam.** See Metam-Sodium
- Basamid Granular.** See Dazomet.

- Bay 25141. See Dasanit.
- Bay 68138. See Nemaicur.
- Bay 70143. See Furadan.
- Bay SRA 3886. See Nemaicur.
- Brifur. See Furadan.
- Bromofume. See Ethylene dibromide.
- Brom-O-Gas. See Methyl bromide.
- Brom-O-Gaz. See Methyl bromide.
- Bromoethane. See Ethylene dibromide.
- Bromomethane. See Methyl bromide.
- Brom-O-Sol. See Methyl bromide.
- Brozone (discontinued by Dow Chemical Co.). Formulation of methyl bromide and chloropicrin in a petroleum solvent.
- Busan 1020. See Metam-Sodium.
- Celfume. See Methyl bromide.
- Celmide. See Ethylene dibromide.
- Chloropicrin. See Fungicides.
- Crag Fungicide 974. See Dazamet.
- Crag Nematicide. See Dazamet.
- Crisfuran. See Furadan.
- Curaterr. See Furadan.
- D 1221. See Furadan.
- Dasanit (Bayer AG; Mobay Corp.). 0,0-diethyl 0-[P-(methylsulfinyl) phenyl] phosphorothioate. General nematicide, also used for plant dip but extremely toxic to mammals. (Use ceased in 1989.) Other names: Bay 25141, S767, Terracur P.
- Dazomet (BASF Aktiengesellschaft; Hopkins Agri. Chem. Co.; ICI Americas, Inc.; UCB Chem Corp.). Tetrahydro-3,5-dimethyl-2H-thiadiazine-2-thione. Used to control soil fungi, nematodes, weeds, and soil insects; preplant treatment for turf and ornamentals. Other names: Basamid Granular, Crag Fungicide 974, Crag nematicide, Dazomet-Powder BASF, DMTT, Micofume, Mylone, N-521, Prezervit.
- Dazomet-Powder BASF. See Dazamet.
- DBCP. 1,2-dibromo-3-chloropropane, nematicide safe around living plants. Sold as Nemagon Soil Fumigant (Shell), Fumazone (Dow), and under other trade names. Can be used as preplant treatment or as side dressing. May be phytotoxic to carnation, chrysanthemum, and dwarf palms. See also Dibromochloropropane.
- D-D 92. See Dichloropropene.
- D-D Soil Fumigant (discontinued by Shell). Dichloropropene-dichloropropane, excellent nematicide, well-suited for large-scale operation, since the fumes need not be confined. Injections are made 12 inches apart. There is little or no control of soil fungi. D-D is not safe around living plants; fields should be treated well in advance of planting.
- Diamidfos. See Nellite.

- Dibromochloropropane** (Dow; Occidental; Shell). 1,2-dibromo-3-chloropropane. Used on nuts, vegetables, and ornamentals. Other names: Nemaforme, Nemanox, Nemaset.
- Dichlofenthion**. (discontinued name). See Dichlorofenthion; Mobilawn.
- Dichlorofenthion** (Pennwalt; Sintesul S.A.). 0-2,4-dichlorophenyl 0,0 diethylphosphorothioate. Used to control non-cyst-forming nematodes on ornamentals and turf. Other names: Tri-VC13, VC13 nematicide. See also Mobilawn (discontinued name).
- Dichloropropene** (The Dow Chemical). 1, 3-dichloropropene. Preplant for nematodes, disease, insect, and weed control on a variety of crops such as vegetables, field crops, citrus, deciduous fruits and nuts, bush and vines, and nursery crops. Apply only as preplant to control nematodes since the chemical is phytotoxic. Applications should not be made in glass-houses containing plants or within 1 meter of the root zone of growing crops in the field. Other names: D-D 92, Telone II Soil Fumigant.
- Di-Trapex**. See Vorlex.
- DMTT**. See Dazomet.
- Dorlone**. See Telone.
- Dow-Fume 75** (discontinued name by The Dow Chemical). Ethylene dichloride 70%, carbon tetrachloride 30%.
- Dowfume C** (discontinued name by The Dow Chemical). Carbon disulfide 12.1%, carbon tetrachloride 81.3%, ethylene dibromide 6.6%.
- Dowfume EB-5** (discontinued name by The Dow Chemical). Ethylene dichloride 29.2%, carbon tetrachloride 63.6%, ethylene dibromide 7.2%.
- Dowfume-59** (discontinued name by The Dow Chemical). Ethylene dibromide 59%, carbon tetrachloride 32%, ethylene dichloride 9%.
- Dowfume F** (discontinued name by The Dow Chemical). Ethylene dichloride 65%, carbon tetrachloride 27%, ethylene dibromide 5%.
- Dowfume MC-2** (discontinued name by The Dow Chemical). Methyl bromide 98%, chloropicrin 2%.
- Dowfume MC-33** (discontinued name by The Dow Chemical). Methyl bromide 67%, chloropicrin 33%.
- Dowfume N** (discontinued name by The Dow Chemical). 1,3-dichloropropene 50%, other chloropropenes.
- Dowfume V** (discontinued name by The Dow Chemical). Carbon tetrachloride 85.1%, ethylene dichloride 12.1%, ethylene dibromide 2.8%.
- Dowfume W-85** (discontinued name by The Dow Chemical). Ethylene dibromide 83%.
- Du Nema**, 4-chloropyridine-N-oxide. Used on turf.
- EDB**. See Ethylene dibromide. (Uses canceled by EPA.)
- EDB-85**. See Ethylene dibromide. (Uses canceled by EPA.)
- E-D-Bee**. See Ethylene dibromide. (Uses canceled by EPA.)
- EDC**. See Ethylene dichloride (Uses canceled by EPA.)
- ED/CT**. See Ethylene dichloride (Uses canceled by EPA.)
- ENT 27164**. See Furadan.

Ethoprop. See Mocap.

Ethylene Dibromide (Excel Industries Ltd.; United Phosphorus Ltd.). 1,2-Dibromoethane. Soil fumigant for nematodes and other pests. Sold as Dowfume, Soil-fume, and Bromofume. Treat in late summer or early fall. Do not use around living plants. Other names: Bromofume, Celmid, E-D-Bee, EDB, EDB-85, Kop Fume, Nephis. (Uses canceled by EPA.)

Ethylene Dichloride (All India Medical Corp.). 1,2-Dichloroethane. Soil fumigant for nematodes and other pests. Treat in late summer or early fall. Do not use around living plants. Other name: EDC. (Uses canceled by EPA.)

Fensulfothion. See Dasanit. (Uses canceled by EPA.)

FMC 10242. See Furadan.

Fumazone (discontinued name). See Dibromochloropropane.

Fumigant-1 (Great Lakes Chem. Corp.) (discontinued name). See Methyl bromide.

Furadan (FMC Agri-Chem Group). 2,3-dihydro-2,2 dimethyl-7-benzofuranyl methylcarbamate. Other names: Bay 70143, Brifur, Crisfuran, Curaterr, D1221, ENT 27164, FMC10242, Furadan, NIA 10242, Yaltox.

Hexa-Nema (discontinued). See Mobilawn.

Hoe 002960. (Hoechst AG). See Hostathion.

Hostathion (Hoechst AG). 1-phenyl-1,2,4-triazolyl-3-(0,0-diethyl-thionophosphoryl). Used on free-living nematodes in vegetable and fruit crops. Other name: HOE 002960.

Jolt (discontinued name). See Mocap.

Karbation. See Metam-Sodium.

Kayafume. See Methyl bromide.

Kop-Fume. See Ethylene dibromide.

Lannate. See Methomyl. (Not registered for use as nematicide.)

Maposol. See Metam-Sodium.

MeBr. See Methyl bromide.

Metam 32.7. See Metam-Sodium.

Metam 42. See Metam-Sodium.

Metam-Fluid BASF. See Metam-Sodium.

Metam-Sodium (BASF Aktiengesellschaft; Buckman Laboratories, Inc.; ICI Plant Protection Division; Pennwalt Holland B.V.; United Agri Products, Inc.). Sodium N-methyldithiocarbamate. General-purpose soil fumigant that is highly effective in control of weeds, weed seeds, nematodes, and soil fungi. Other names: A7 Vapam, Busan 1020, Karbation, Maposol, Metam 32.7, Metam 42, Metam Fluide BASF, Nemasol, Solasan 500, Sometam, Trimaton, Vapam, VPM.

Metham. See Metam-Sodium.

Metham-Sodium. See Metam-Sodium.

Meth-O-Gas. See Methyl bromide.

Methomyl (DuPont; Chrystal Chem. Inter-America). S-methyl-N-((methyl-carbamoyl) oxy) thioacetimidate. An insecticide-nematicide used in vegetables,

fruits, and ornamentals. Other names: Lannate, Lanox 90, Lanox 216, Methomex, Metox-900, Nudrin. (Not registered for use as nematicide.)

Methyl bromide (Great Lakes Chemical Corp.). Bromomethane. Soil fumigant, supplied under that name by a number of manufacturers. It is used in greenhouses because it is somewhat less toxic to plants than most other fumigants and for bailed or potted nursery stock in special fumigating chambers. As Dowfume MC-2, methyl bromide with 2% chloropicrin, it comes in cans with a special dispenser. The area to be treated is covered with plastic film, under which are evaporating pans with hoses leading to the edge of the cover. The dispenser is attached to each hose in turn to fill the pans, and then the edges of the cover are held down with soil. For small areas injections are made 10 inches apart. This material is very poisonous; follow all safety precautions. Other names: Brom-O-Gas, Brom-O-Gaz, Brom-O-Sol, Celfume, Kayafume, MeBr, Meth-O-Gas, Terr-O-Cide II, Terr-O-Gas.

Methyl isothiocyanate. See Vorlex.

Micofume. See Dazomet.

Mobilawn (discontinued name by Mobil Chemical Co.). 0-2,4-dichlorophenyl 0,0 diethylphosphorothioate. Used to control non-cyst-forming nematodes on ornamentals and turf.

Mocap (Rhone-Poulenc Ag. Co.). 0-ethyl, S-S-dipropyl phosphorothioate. Used to control nematodes on sweet potato, banana, cabbage, corn, pineapple, peanuts, cucumber, snap and lima beans, white potato, and selected ornamentals and turf.

Mylone. See Dazomet.

N 521. See Dazomet.

Nellite (discontinued by The Dow Chemical), phenyl N,N'-dimethyl phosphorodiamidate. Used on tobacco to control rootknot nematodes.

Nemacur (Bayer AG; Mobay Agri. Chem. Div.). Ethyl 3-methyl-4-(methylthio) phenyl (1-methylethyl) phosphoramidate. Used to control major genera of nematodes attacking peanuts, cabbage, brussel sprouts, and turf. Other names: Bay 68138, Bay SRA 3886.

Nemafene. See D-D Soil Fumigant.

Nemafume. See Dibromochloropropane.

Nemagon (discontinued by Shell). Nematicide safe around living plants. See also Dibromochloropropane (DBCP).

Nemanex. See Dibromochloropropane.

Nemaset. See Dibromochloropropane.

Nemasol. See Metam-Sodium.

Nephis. See Ethylene dibromide.

NIA 10242 (FMC Corp.). See Furadan.

Nudrin. See Methomyl. (Not registered for use as nematicide.)

OMS 771. See Temik.

Pestmaster (discontinued by Velsicol Corp.). See Methyl bromide.

Prezervit. See Dazomet.

- Profume** (discontinued by Dow Chem.). See Methyl bromide.
- Prophos** (discontinued name). See Mocap.
- Rotox** (discontinued by Ferguson Fumigants). See Methyl bromide.
- S 767**. See Dasanit.
- Sarolex** (Geigy). Nematicide-insecticide, a special formulation of Diazinon and formerly for some nematodes in southern turf grasses.
- SMDC**. See Metam-Sodium.
- Sodium methyldithiocarbamate**. See Metam-Sodium.
- Solasan 500**. See Metam-Sodium.
- Sometam**. See Metam-Sodium.
- Telone**. See Dichloropropene.
- Telone II Soil Fumigant**. See Dichloropropene.
- Temik** (Rhone-Poulenc Ag. Co.; Union Carbide). 2-methyl-2-(methylthio) propionaldehyde O-(methylcarbamol) oxime. Insecticide-acaricide with nematocidal activity. Other names: OMS 771, UC 21149.
- Temik Brand**. See Temik.
- Terra-cur**. See Dasanit.
- Terr-O-Cide** (discontinued by Great Lakes Chemical Corp.). Combinations of ethylene dibromide and chloropicrin, or 1,3-dichloropropene, 1,2-dichloropropane, and related chlorinated hydrocarbons with chloropicrin. Used to control nematodes and fungi in soils.
- Terr-O-Gas** (Great Lakes Chemical Corp.). Various percentage proportions of methyl bromide and chloropicrin. Used to control nematodes and fungi in soils.
- Tiazon**. See Dazomet.
- Tirpate** (discontinued by 3M Co.). 2,4-dimethyl-1,3-dithiolane-2-carboxaldehyde O-(methylcarbamoyl)oxime. Used to control nematodes.
- Triazophos**. See Hostathion.
- Trimaton**. See Metam-Sodium.
- Tri-VC 13**. See Dichlofenthion.
- Trizone** (Dow Chemical). Methyl bromide, chloropicrin, 3-bromoproparyl bromide, and related compounds. A nematicide to be used with caution. See also Methyl bromide.
- UC 21149**. See Temik.
- Vapam**. See Metam-Sodium.
- VC-13 Nematicide**. See Dichlofenthion.
- Vidden D** (Dow Chemical Co.). Mixture of dichloropropane-dichloropropene. Used to control nematodes in soils.
- Vorlex** (Nor-Am Chem. Co.; Schering AG). Methyl isothiocyanate, 1,3-dichloropropene and other chlorinated hydrocarbons). Preplant soil fumigant to control weeds, fungi, insects, and nematodes in potatoes, tobacco, vegetables, and ornamentals. Other name: Di-Trapex.
- VPM**. See Metam-Sodium.
- Yaltox**. See Furadan.

VIROCIDES

Cytovirin. Antiviral antibiotic, inhibiting mosaic in bean and tomato.
Dimanin C. See Bactericides.

SOURCES OF PESTICIDES

Applied Industrial Materials Corp. One Parkway North, Suite 400, Deerfield, IL 60015.
AgBiochem Inc., 3 Fleetwood Ct., Orinda, CA 94563.
Agrimont S.p.A, Piazza della Repubblica 14/16, 20124 Milano, Italy.
Agtrol Chemical Products, 7324 Southwest Freeway, New Orleans, LA 70112.
Agway, Inc., Box 4741, Syracuse, NY 13221.
All India Medical Corp., Akhand Jyoti 8th Road, P.O. Box 16806, Santacruz East, Bombay 400 055, India.
American Cyanamid Company, One Cyanamid Plaza, Wayne, NJ 07470.
American Hoechst Corporation, Agricultural Division, 11312 Hartland Street, North Hollywood, CA 91605.
Artel Chemical Corp., 91 Carolyn Blvd., Farmingdale, NY 11735-1527.
BASF Aktiengesellschaft, Carl-Bosch-Str. 38, D-6700/Ludwigshafen, Federal Republic of Germany.
Bayer AG, Sektor Landwirtschaft, Pflanzenschutzzentrum Monheim, 5090 Leverkusen Bayerwerk, Federal Republic of Germany.
The Boots Co., Ltd., Agro Chemical Division, 1 Thane Rd. West, Nottingham, England.
Buckman Laboratories, Inc., 1256 N. McLean Blvd., Memphis, TN 38108.
Celamerck GMBH & Co. KG, P.O. Box 202, 6507 Ingelheim/Rhein, West Germany.
Chemagro Agricultural Division, Mobay Chemical Corporation, P.O. Box 4913, Hawthorn Road, Kansas City, MO 64120.
Chemical Formulators, Inc., Box 26, Nitro, WV 25143.
Chemical Interprises, Inc., 8582 Katy Freeway, Suite 202, Houston, TX 77024-1854.
C.P. Chemicals Inc., P.O. Box 21, 7B Terminal Way, Avenel, NJ 07001.
Chevron Chemical Company, 6001 Bollinger Canyon Road, Building T, P.O. Box 5047, San Ramon, CA 94583-0947.
Chipman Chemicals, Inc., Box 718, River Rouge, MI 48218.
Ciba-Geigy Corp, P.O. Box 18300, Greensboro, NC 27419-8300.
Cities Service Co., Industrial Chemicals Marketing Dept., Box 50360, Atlanta, GA 30302.
W. A. Cleary Corporation, Box 10, 1049 Somerset St., Somerset, NJ 08873.
Crystal Chemical Co.-Inter America, 1525 N. Post Oak Rd., Houston, TX 77055.

- Davison Chemical Division, W. R. Grace & Co., Charles and Baltimore Streets, Box 247, Baltimore, MD 21203.
- Diamond Shamrock Chemical Co., 300 Union Commerce Building, 1100 Superior Ave., Cleveland, OH 44114.
- Dow Chemical Company, 2020 Willard H. Dow Center, Midland, MI 48674.
- Drexal Chemical Co., 2487 Pennsylvania St., Memphis, TN 38109.
- Duphar B.V., Crop Protection Div., P.O. Box 4, 1243 2G-s-Graveland, The Netherlands.
- Duphar-Midox Ltd., Smarden, Kent, England TN 278QL.
- E. I. DuPont de Nemours & Company, Industrial & Biochemical Department, 1007 Market St., Wilmington, DE 19898.
- Elanco Products Company, Division of Eli Lilly & Co., Lily Corporate Center, Indianapolis, IN 46285.
- Excel Industries, Ltd., 184-87 Swani Vivekanand Road, P.O. Box 7474, Jogeshwari, Bombay 400102, India.
- Fabriek van Chemische Producten Vondelingenplaat B.V., P.O. Box 7120, Rotterdam 3031, Netherlands.
- Ferguson Industries, 1900 W. Northwest Highway, Dallas, TX 75220.
- Fermenta Plant Protection Co., 5966 Heisley Rd., P.O. Box 8000, Mentor, OH 44060-8000.
- FMC Corporation, Agricultural Chemicals Group, 2000 Market St., Philadelphia, PA 19103.
- Great Lakes Chemical Corp., P.O. Box 2200, West Lafayette, IN 47906.
- Griffin Ag. Products Co., Inc., P.O. Box 1847, Valdosta, GA 31603.
- Harshaw Chemical Co., 1945 E. 97th St., Cleveland, OH 44106.
- Hoechst AG, Agricultural Div., Postfach 80 03 20, D-6230 Frankfurt (80) FR.G., Germany.
- Hokko Chemical Industry Co., Ltd., Mitsui Bldg. No. 2, 4-4-20, Nihonbashi Hongokucho-Cho, Chuo-ku, Tokyo, Japan.
- Hopkins Agricultural Chemical Co., P.O. Box 17532, Madison, WI 53707.
- ICI Agrochemicals, Fernhurst, Haslemere, Surrey GU27 3JE, United Kingdom.
- ICI Americas, Inc., Agricultural Chemicals Div., Wilmington, DE 19897.
- Kaken Pharmaceutical Co., Ltd., 3-4-10, Nihonbashi-Honcho, Chuo-Ku, Tokyo 103, Japan.
- Kalo Inc., 4550 West 109 Street, Overland Park, KS 66211-1351.
- Keno Gard AB, P.O. Box 11555, S-10061 Stockholm, Sweden.
- Kerr-McGee Chemical Corp., Kerr-McGee Center, Oklahoma City, OK 73125.
- Kincaid Enterprises, Inc., P.O. Box 549, Nitro, WV 25143.
- Kocide Chemical Corp., 12701 Alameda Rd., Houston, TX 77045.
- Kumiai Chemical Industry Co., Ltd., 4-26 Ikenohata, 1-chome Taitoh-ku, Tokyo 110, Japan.
- LaCorunbia S.A., 85 Quai de Brazza, Bordeaux 33100, France.
- Leffingwell, A Business of Uniroyal Chemical Co., Inc., 111 South Berry St., P.O. Box 1880, Brea, CA 92621.
- Lonza, Inc. 22-10 Rt. 208, Fairlawn, NJ 07410.

- Lowes Industrial Products Div., Edward Lowe Industries, 348 South Columbia St., P.O. Box 16, South Bend, IN 46624.
- Makhteshim-Agan, P.O. Box 60, 84100 Beer-sheva, Israel.
- Mallinckrodt Chemical Works, Mallinckrodt and Second St., P.O. Box 5439, St. Louis, MO 63147.
- A. H. Marks & Co., Ltd., Wyke Lane, Wyke Bradford, W. Yorkshire, England.
- Merck & Company, Inc., 126 Lincoln Ave., P.O. Box M, Rahway, NJ 07065.
- Michigan Chemical Corp., 2 N. Riverside Plaza, Chicago, IL 60606.
- Miller Chemical & Fertilizer Corporation, P.O. Box 333, Hanover, PA 17331.
- Mineral Research and Development Corporation, One Woodlawn Green, Charlotte, NC 28217.
- Mobay Corp. Agricultural Chemicals Div., P.O. Box 4913, 8400 Hawthorn Rd., Kansas City, MO 64120.
- Mobil Chemical Company, 150 East 42nd St., New York, NY 10017.
- Monsanto Chemical Company, 800 N. Lindbergh Boulevard, St. Louis, MO 63167.
- Montedison DIPA, Agricultural Products Div., Piazza Della Repubblica 14/16, 20100 Milano, Italy.
- Nationwide Chemical Company, 2209 Fowler St., P.O. Box 775, Fort Myers, FL 33902.
- Nihon Nohyaku Co., Ltd., 2-5 Nihonbashi 1-chome Chuo-ku, Tokyo, Japan.
- Nippon Soda Co., Ltd. Agro-Pharm Div., 2-2-1 Ohtemachi, Chiyoda-ku, Tokyo 100, Japan.
- Nor-Am Agricultural Products, Inc., 20 N. Wacker Dr., Chicago, IL 60606.
- Nor-Am Chemical Co., 3509 Silverside Rd., P.O. Box 7495, Wilmington, DE 19803.
- Nutrilit Products, Inc., 5600 Beach Blvd., Buena Park, CA 90620.
- Nysjon Soda Co., Ltd., Fine Chemical Division, Shin-Oktemachi Bldg. No. 2-2-1 Ohtemachi, Chiyoda-Ku, Tokyo, Japan.
- Occidental Chemical Co., P.O. Box 198, Lanthrop, CA 95330.
- Old Bridge Chemicals, P.O. Box 194, Old Bridge, NJ 08857.
- Olin Corporation, P.O. Box 991, Little Rock, AR 72203.
- Pennwalt Corp., Agchem. Div., 3 Parkway, Philadelphia, PA 19102.
- Pennwalt Holland B.V., Production Dept., P.O. Box 7120, 3000 H.C. Rotterdam, Holland.
- Pfizer Inc., MPM Division, 235 East 42nd St., New York, NY 10017.
- Phelps Dodge Refining Corp., P.O. Box 20001, El Paso, TX 79998.
- Probelte, S.A., Ctra. de Madrid, Km 384'6 Apartado 579, Murcia, Spain.
- Procida S. A., 5 rue Bellini, 92 806 Puteaux, France.
- Rhodia, Inc., Agricultural Division, P.O. Box 125, Monmouth Junction, NJ 08852.
- Rhone-Poulenc Agrochimie S.A., 14-20 rue Pierre Baizet, 69009 France.
- Roberts Chemicals, Inc., Box 446, Nitro, WV 25143.
- Rohm & Haas Company, Independence Mall West, Philadelphia, PA 19105.
- Sandoz, Ltd., Agro Div., Lichstrasse 35, CH4002, Basle, Switzerland.

- Sankyo Company, Ltd., No. 7-12, Ginza 2-chome, Chuo-Ku, Tokyo 104, Japan.
- Schering AG, Agrochemical Div., P.O. Box 65 03 11, D-100 Berlin 65, West Germany.
- Shell Agrar GmbH & Co., KG, P.O. Box 202, 6507 Ingleheim/Rhein, FR.G.
- Shell Development Company, Agricultural Research Division, 2401 Crow Canyon Rd., San Ramon, CA 94583.
- Shell International Chemical Co., Ltd., Shell Centre, London SE1 7PG England.
- Sierra Chemical Co., 1001 Yosemite Drive, Milpitas, CA 95035.
- Sintetul, Rua Joas Thomaz Munhoz 218, Caixa Postal No. 263, Pelotas, Rio Grande do Sul, Brazil 96.100.
- Stauffer Chemical Company, Agricultural Chemical Div., Westport, CT 06880.
- Sumitomo Chemical America, Inc., 345 Park Ave., New York, NY 10154.
- Sunko Chemical Co., Ltd., No. 12, Lane 42, Jen-Hua Rd., Ta-li Hsiang, Taichung Hsien, Taiwan, R.O.C.
- Takeda Chemical Industries, Ltd., 12-10 Nihonbashi 2-chome, Chou-ku Tokyo 103. Japan.
- Tennessee Chemical Co., 3475 Lenox Rd., N.E., Suite 670, Atlanta, GA 30326.
- Thompson-Hayward Chemical Co., 5200 Speaker Rd., Kansas City, KS 66106.
- Tifa Ltd., Tifa Square, 50 Division Ave., Millington, NJ 07946.
- Tower Chemical Co., P.O. Box 585, Clermont, FL 32711.
- Transvaal, Inc., P.O. Box 69, Marshall Rd., Jacksonville, AR 72076.
- Troy Chemical Corp., One Avenue L, Newark, NJ 07105.
- UCB Chemicals Corp., 5365-A Robin Hood Rd., Norfolk, VA 23513.
- Union Carbide Corporation, Agricultural Products Co., P.O. Box 12014, Research Triangle Park, NC 27709.
- Uniroyal Chemical Co., Inc., Crop Protection Div., World Headquarters, Middlebury, CT 06749.
- Uniroyal, U.S. Rubber Company, Emic Bldg., Naugatuck, CT 06770.
- United Agri-Products, P.O. Box 1286, Greeley, CO 80632.
- United Phosphorus Ltd., 167 Dr. Annie Besant Road, Worli, Bombay 400 018, India.
- Universal Crop Protection, Ltd., Park House, Maidenhead Rd., Cookham, Berkshire, SL6 9DS United Kingdom.
- Upjohn Company, TUCO Products Co. Div., 7000 Portage Rd., Kalamazoo, MI 49001.
- R. T. Vanderbilt Co., Inc., 30 Winfield St., Norwalk, CT 06855.
- Velsicol Chemical Corporation, 341 E. Ohio Street, Chicago, IL 60611.
- Vineland Chemical Co., Inc., 1611 West Wheat Rd., Vineland, NJ 08360.
- Visplant Chemiren S.R.L., Via Salviz, 44045 Renazzo de Cento Ferrara, Italy.
- Wesley Industries, Inc., P.O. Box 490, Montrose, AL 36559.
- Woolfolk Chemical Works, Inc., P.O. Box 938, Fort Valley, GA 31030.

APPLYING THE CHEMICALS

Spraying is the application of a chemical to a plant in liquid form; *dusting* is the application of a fine dry powder. The difference between spraying and dusting was very clear-cut before aerosol bombs, mist blowers, and fog machines were developed to apply liquids in such concentrated form that the particles are practically dry before they reach the plant and before spray-dusters were made to deliver wetted dusts.

Sprayers vary from a flit gun or pint atomizer that takes an hour to discharge a gallon, to power apparatus that discharges 60 gallons a minute at 800 pounds pressure from a 600-gallon spray tank. Dusters vary from the small cardboard or plastic carton in which the dust is purchased to helicopters. Applicators for pressurize sprays or aerosols vary from the one-pound "bomb" to truck-mounted fog generators or air blast machines. See Figure 1 for various applicators.

Mist Sprayers

In orchards and in shade tree work there has been increasing use of mist blowers, air blast machines that carry droplets of concentrated pesticides to plants in air rather than water. They are speedier than hydraulic sprayers, use far less water, which may be scarce in times of drought, and do not leave puddles or poisonous runoff that may be dangerous to pets and birds. They cannot, however, be operated in much wind; for that reason, and also in order to see the distribution of the concentrates, they often have to be used at night. They are not too efficient for very tall trees, and the droplet size has to be rather carefully regulated. Too large drops may fall out before they reach a tree, and too small drops may not settle down.

Although we usually think of mist blowers on trucks for large-scale operations, there are now some about the size of knapsack sprayers that, engine and all, are worn on the back around the garden. They weigh around 35 pounds and will cover foliage up to 30 feet. They cost somewhat more than the hydraulic power sprayers of small estate size.

Hydraulic Sprayers

Mist blowers will probably never entirely outmode hydraulic sprayers, which can place the spray more accurately, at a greater height, and can operate under more unfavorable weather conditions. For trees, high gallonage per minute and enough pressure to drive sprays high in the air have advantages, but for garden plants the emphasis should be on cutting down gallonage and pressure.



Figure 1. Pesticide application equipment. (Modified from the National Sprayer and Duster Association.)

Power sprayers for home gardens are available in almost any size, from 5-gallon capacity on up, and may have gasoline or electric motors (see Fig. 2). For the orchard a spray gun is satisfactory, but for flowering shrubs—azaleas, roses, and so on—a spray rod, curved at the end, or with an angle nozzle, is easier on the plants and more effective, allowing for better coverage on the underside of foliage.

The size of the hole in the nozzle disc and the pressure determine the amount of spray used. The volume of spray ejected per minute doubles or triples with each small increase in the hole size or pressure used. Thus, in a home garden where the objective is to cover a few rose bushes effectively, a



Figure 2. Spray application techniques.

large amount of spray can be wasted at too high pressure, an expensive item with many pesticide mixtures costing 20 to 30 cents a diluted gallon. Most chemicals are corrosive, and even if you start with a mist nozzle with a small hole at the beginning of the season, you will soon be delivering more spray per minute because the hole is enlarging. Therefore, there is more conspicuous residue left on the plant as well as more expense.

Hand-Operated Sprayers

“Aerosol bombs” are pressurized sprays in push-button containers. A gas propellant reduced to liquid form is added to a pesticide concentrate and a fine mist is released when the button is pushed. Unless the container is held 12 to 18 inches away from plants, to allow the gas to evaporate, there will be some burning (more literally a freezing) when the liquid gas hits foliage. Such cans are good for house plants and for spot treatment of insects outdoors, but air currents make it difficult to place fungicides effectively. Aerosols are also used for the application of wound dressings to trees (see Fig. 3).

Household sprayers of the atomizer type are intermittent, discharging spray material with each forward stroke of the pump; or continuous, maintaining constant pressure. They are too small and too tiresome to operate for



Figure 3. Aerosol pressurized spray.

more than a few plants, and it is hard to get adequate coverage on the underside of foliage.

Compressed air sprayers are adequate for small gardens and are relatively inexpensive. Capacity varies from 1 to 6 gallons. They are meant to be carried slung over one shoulder, but some come mounted on a cart. Air is compressed into the tank above the spray liquid by a hand-operated pump. A short hose, extension rod, and adjustable nozzle make it possible to cover undersurfaces. Such sprayers are a bit hard to pump up, and some models have carbon dioxide cylinders to provide operating pressure.

Knapsack sprayers, of 2 to 6 gallons capacity, are carried on the back of the operator and are pumped by moving a lever up and down with the right hand as you spray with the left. These are more expensive than compressed air sprayers, but deliver a fine continuous mist and are excellent for larger gardens.

Slide or trombone sprayers have a telescoping plunger, operated with two hands. They draw material from an attached jar or separate pail and discharge it as a continuous spray. They develop good pressure and can be used for small trees, but are tiring to use.

Wheelbarrow sprayers are manually operated hydraulic sprayers, holding 7 to 18 gallons, that are mounted on a frame with wheelbarrow-type handles and one or two wheels. Pressures up to 250 pounds may be developed,

providing excellent coverage for shrubs and small trees. This type works best with two people: one to control the pump, the other to operate the spray rod.

Hose-end sprayers are attached to the garden hose so that water supplies the pressure. The action is that of a siphon. The concentrated pesticide is placed in a jar, and as water under pressure is passed over the metering jet a small amount of chemical is drawn into it. This way to spray is very easy and some models are relatively accurate in materials discharged. Be sure to purchase a type with an extension tube and deflector, so that spray can be directed to underside of the foliage, with a shutoff at the jar, not just back at the hose, and with a device to prevent back-siphonage. Hose-end sprayers can be used for roses and other shrubs and for low trees. The droplets may be somewhat larger than those from a wheelbarrow or knapsack sprayer, and slightly more chemical may be used.

Dusters

Pesticide dusts are most often made with talcs, pyrophyllite, clays, calcium carbonate, precipitated hydrated silicates and silicon dioxides, synthetic calcium silicate, and diatomaceous earth as the diluents, although finely ground plant material such as tobacco dust or walnutshell flour is sometimes used. In some cases, a solution of the toxicant in a volatile organic solvent such as acetone or benzene is mixed with the dust diluents, the solvent is allowed to evaporate, and the mixture is then ground. A solution of toxicant may be sprayed on the dust diluent during mixing and grinding or the toxicant may be dissolved in a nonvolatile solvent and mixed with the diluent. Care must be taken to avoid an excess of solvent that might impair dusting qualities of the finished product. Many technical pesticides in solid form lend themselves to direct grinding with a sorptive clay carrier in adequate milling equipment. Field-strength dusts may be produced by diluting or cutting down dust concentrates that contain from 10% to 50% a.i. (dust bases). Because of their good dusting properties, attapulgites, diatomite, talc, pyrophyllite, kaolins, and treated calcium carbonate are used as diluents to provide the volume per acre needed to facilitate metering of the dust through the duster mechanism. Since many formulations contain more than one a.i., dry concentrates must have the proper qualities to make a good formulation with relatively little or no diluent. From a toxicity standpoint, it is desirable to have a very small particle size, since immediate toxicity is generally inversely proportional to particle size. There are several important disadvantages to extremely small particle size: high wind losses, more or less rapid volatilization, and the prohibitive cost of extremely fine grinding. Also, to obtain better toxicant exposure of technical concentrates absorbed on a carrier, it is desirable to have the extender or diluent in as large a particle size as possible and still give good dusting characteristics. In a 5% dust-effective toxicant exposure is obtained with the extender averaging 10 times the size of the toxicant particles. At present,

particle size specifications are usually 10 to 30 microns for ground dusters and 20 to 40 microns for aircraft units. For use in fertilizer mixtures, granulated powders of 20 to 80 mesh are prepared by impregnation of Fuller's earth and bentonite fractions with the desired toxicants.

Some dusts are sold in a can with a shaker top, meant to be applied like salt, which is certainly not going to place a fungicide where it will do the most good. Some dusts are sold in small cardboard cylinders to be used as dusters, which work for a little while if the cardboard is well paraffined to slide easily; but the dust soon gets damp and clogs. Many more dusts are sold in plastic containers, with the dust supposedly coming out in clouds as you squeeze, but more often it doesn't after the first few days. Dusts are tricky to use because of these disadvantages.

Spraying Versus Dusting

There is really no answer to the question of whether it is better to dust or to spray. In most gardens you will do both, depending on the weather, the plant, the fungicide you want to use, and how much time and help you have.

Some orchardists prefer dusting because they can get around the trees quickly in a rain, whereas to apply a spray they must wait until the foliage is dry. But for ornamentals exactly the opposite is true! You cannot dust a shrub even slightly wet with rain or dew without having a hideous splotchy effect that persists for a long time. If absolutely necessary you can spray while the plants are still slightly wet, though the spray may not stick quite as well, and you may want to make the next application a bit sooner. It is easier to spray than to dust on a windy day. Also, in dusting you are somewhat more likely to get possibly toxic materials into your lungs than in spraying. The chief points in favor of dusting are the ease and speed of application and the fact that you do not have to clean out the duster after each dusting.

Sprayers have to be cleaned, often between different sprays, and they must be rinsed with at least two changes of water pumped through the system at the end of every day. Occasionally they must be taken apart, the tank soaked in trisodium phosphate or washing soda, the strainers and nozzles in kerosene, wire run through the spray rods, then all put together and rinsed with water. Details of this cleaning chore are given in the *Gardener's Bug Book*.

MIXING THE CHEMICALS

It still seems incredible that so many gardeners continue to treat their plants in a haphazard fashion. Buy a set of measuring spoons and a measuring cup, marked in ounces. Buy a large pail and mark it off in gallons. Then measure, exactly!

Dosage directions are usually given in pounds per 100 gallons of water, with or without translation on the label into small amounts. Not much arithmetic is required to figure a smaller dosage, if you remember a few measurements:

Conversion Table

| | | |
|-------------------|---|---------------------|
| 3 teaspoons | = | 1 tablespoon |
| 2 tablespoons | = | 1 fluid ounce |
| 16 tablespoons, | | |
| 8 fluid ounces | = | 1 cup |
| 16 ounces, 2 cups | = | 1 pint |
| 2 pints, 4 cups | = | 1 quart |
| 16 cups, 8 pints | = | 4 quarts = 1 gallon |
| 1 acre | = | 43,560 square feet |

Suppose 3 gallons of a 2 to 100 dilution of lime sulfur is desired. That is the same as a 1 to 50 dilution. Three gallons constitute 48 cups; so if 1 cup of liquid lime sulfur is added to 3 gallons, you will have a 1 to 49 dilution, and that is close enough.

Or suppose you want to make 4 gallons of Zineb at the rate of 1½ pounds per 100 gallons. That is 24 ounces per 100 gallons, or .24 ounce for 1 gallon and .96 ounce for 4 gallons. That is approximately 1 ounce to weigh on your small scales. It also works out at about 1 level tablespoon of the Dithane powder per gallon, and it is easier to measure than to weigh. There is, however, a good deal of volume variation, depending on how fluffed up the material is at the time you measure it, so weighing is preferable.

When you buy chemicals in small packages designed for the home garden, the dosages given on the labels will probably be in terms of tablespoons per gallon, and you need only follow directions. When, to save a good deal of expense, you buy the larger sizes intended for farmers, the directions may be given only in terms of pounds per 100 gallons. As a very rough rule of thumb, you can figure 1 tablespoon per gallon where directions call for 1 pound per 100 gallons, but the different mixtures have different weights, so this is not very accurate.

At the rate of 1 pound to 100 you would use, accurately, ¾ tablespoon captan 50%, 1 tablespoon chloranil (Spergon), 1/3 tablespoon copper sulfate, 2/3 tablespoon dichlone 50% (Phygon), 1/4 tablespoon ferbam, 1/2 tablespoon maneb, 1 tablespoon spray lime, 3/4 tablespoon thiram, 1/2 tablespoon sulfur, 2/3 tablespoon zineb (Dithane Z-78 or Parzate), 1/4 tablespoon ziram to 1 gallon of water.

Sometimes materials for soil treatment are given in pounds per acre. Knowing that one acre contains 43,560 square feet, you can make a proportion to find out how many pounds are required per 1000 square feet.

ALL-PURPOSE SPRAYS AND DUSTS

The practicability of combination insecticide-fungicide mixtures is sometimes argued. The proprietary compounds are more expensive, but they are more properly prepared than can be done at home and certainly save a lot of time. Nobody today could put on separate applications of all the materials needed. The trouble is that the mixtures follow fads, as in human medicine. Just as penicillin was given for most human ills some years ago, DDT was put in almost all pesticide mixtures, followed a little later by malathion. Both are excellent insecticides. The trouble is they are somewhat too efficient, killing the parasites and predators that keep mites and some other pests in check and they also may damage the environment. Some of the new fungicides leave a rather conspicuous residue; some are somewhat phytotoxic under certain conditions. Some of these pesticides are no longer available owing to new federal pesticide legislation; however, new materials are available that will replace those whose use is illegal. Every mixture must be evaluated for particular climatic situations and kinds of plants. There are hundreds and hundreds of combinations on the market under brand names. In order not to be out of date before this text is printed, I have used as few brand names as possible.

INTEGRATED PEST MANAGEMENT

In recent years pesticides have been constantly scrutinized. Registrations of many pesticides have been canceled. The diminished availability of pesticides may limit choices to more costly materials. In addition, there is growing concern about groundwater contamination by pesticides and fertilizers, pesticide resistance in plant pathogens, insects and weeds, destruction of beneficial organisms, atmospheric contamination by pollutants, and concern for endangered species, all of which combine to make the problem of pest control more serious.

For the past 20 years integrated pest management (IPM) has received increased interest. Investigations have concentrated on enhancement of a broad arsenal of integrated strategies for control of pests and diseases on selected commodities. A key goal of IPM strategies is the reduction of pesticide use to the absolute minimum and the reliance on other strategies to assist in controlling pests. One of those strategies is biological control.

Intense research in biological control of root diseases has been proceeding in the United States and in Europe. Some microbial agents, although sometimes sensitive to environmental variation, can be effective in controlling soil-borne plant pathogens. Although there are many promising fungal and bacterial biocontrol agents, and experiments demonstrate successful biocontrol in the greenhouse and field, there are few commercially available biocontrol products. The reasons may be due to an insufficient understanding of the

mode of action of most biocontrol agents, to a need to develop mass production and delivery systems, to little methodology for integrating biocontrol with other control strategies and crop production methods, and to competition of the biocontrol agent with other microorganisms.

The most widely known biocontrol of plant disease is Galltrol-A, which contains *Agrobacterium radiobacter* (strain 84) and is used as a preventative control of crown gall. Moreover, *Trichoderma* species, fungi associated with debris in many soils, are known to be antagonistic against several fungal pathogens that cause root and stem diseases. A strain of *Trichoderma* (T-1-R9) has been developed that is tolerant to benomyl. When T-1-R9 is added to soil in pots, Fusarium wilt disease of chrysanthemum and carnation is reduced more than 50%. In this case, benomyl can be applied to the foliage to control foliar diseases without endangering the biocontrol of Fusarium wilt. Another promising biocontrol fungus is *Sporiddermium sclerotivorum*. A single application of this fungus to soil reduces lettuce drop by 65%–85%. Field experiments revealed efficacy through consecutive lettuce plantings over a 2-year period. Some *Trichoderma* strains are being investigated as seed coatings.

Mass production and good delivery systems are required for biocontrol agents. Biocontrol fungi are grown in industrial fermentation systems on cheap feed sources such as molasses and brewer's yeast; then they are mixed with inert powders or converted into sprays or pellets. Gelling agents used in food processing are added to make pellets that resemble some plant fertilizers. The pellets are uniform in size, biodegradable, and nontoxic.