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PROTECTING MATERIALS AGAINST FUNGI BY APPLYING SUBSTITUTED DITHIONO AND THIONO-OXO-THIADIAZOLIDINES

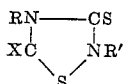
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6 Claims. (Cl. 167—33)

This invention relates in general to fungicidal materials and their preparation and more particularly to diphenyl and dialkyl 1,2,4-thiadiazolidines and to their preparation.

Broadly, this invention relates to the preparation of diphenyl and dialkyl thiadiazolidines which have fungicidal and fungistatic properties and which have the general formula:



wherein R is an alkyl or phenyl group, R' is also an alkyl or phenyl group and X is an O or S atom. Certain of these compounds may be prepared by oxidizing sodium N-alkyl dithiocarbamates, RNHCS_2Na .

More particularly, this invention relates to chemical compositions which have fungicidal and fungistatic properties, these chemical compositions being represented by the general formula set forth above wherein R and R' are preferably methyl, ethyl, propyl, butyl, pentyl and hexyl. The letter X designates oxygen or sulphur. The preferred compounds of this invention are 2,4-dimethyl-3,5-dithiono-1,2,4-thiadiazolidine (N-1045); 2,4-dimethyl-3-thiono-5-oxo-1,2,4-thiadiazolidine (N-1038); diethyl analogs of the above two compounds (N-1426 and N-1425); the dipropyl analogs of the above (N-1483 and N-1490); the dibutyl analog of N-1045 (N-1427); and the hydrobromide of the dihexyl analog of N-1045 (N-1448). The phenyl analogs of 1045 and 1038 have also been tested and found effective, but to a lesser extent than certain of the other compounds tested above. Also, compounds having differing substituents as R and R₁ are effective as fungicides, but because of the greater ease of manufacture of the compounds having identical substituents in the R and R₁ position, the latter are preferred. Since the names of these compounds are somewhat unwieldy, code numbers have been assigned (those shown in parentheses above) and throughout the balance of the specification reference is made to these compounds by said code numbers. A tabulation of the codes and structures involved is as follows:

Code Number	R & R'	X
N-1045	Methyl	S
N-1038	Methyl	O
N-1426	Ethyl	S
N-1425	Ethyl	O
N-1483	n-Propyl	S
N-1490	n-Propyl	O
N-1427	n-Butyl	S
N-1448*	n-Hexyl	S
N-1066	Phenyl	S
N-1043	Phenyl	O

*N-1448 was used as the hydrobromide.

Some of these compounds, the dialkyl thiadiazolidines,

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may be readily prepared by contacting the corresponding moist, solid sodium N-alkyl dithiocarbamate with air, or an oxygen-containing gas, at elevated temperatures. The formation of the dialkyl thiadiazolidines under these conditions is favored if the solid dithiocarbamate is in the form of a moist (hydrated) fine powder. In the case of N-1045, it has been found that it may be prepared by contacting moist, hydrated solid sodium N-methyl dithiocarbamate with air in a pneumatic-conveying drier (flash drier) as described, hereinafter, more fully in the non-limiting Example II. Other means, well-known in the art, of contacting the moist, solid dithiocarbamates with an oxygen-containing gas at elevated temperatures are suitable for this preparation. Temperatures should be above 100° C., and preferably in the range of about 130° to 250° C.

In order to show the effectiveness of these compounds as fungicides, the following tests were carried out:

Agar plate test.—In testing the compound for fungitoxicity by this method, the compound is dispersed evenly throughout 20 ml. of warm potato dextrose agar on a petri dish. A series of plates containing various concentrations of the compound are prepared for each fungus species used. When the agar has cooled and solidified, the center of each plate is seeded with a few spores of the desired fungus. After seven days incubation in the dark under controlled temperatures of 20° C., the diameter of the fungus colony on each plate is measured and the relationship between the growth on each plate and that on an untreated but seeded control plate is recorded as percent control (or percent inhibition of growth). The results with N-1045 are set forth below in tabular form:

TABLE I

	Percent control at—			
	p. p. m., 500	p. p. m., 100	p. p. m., 50	p. p. m., 25
<i>Aspergillus niger</i>	100	100	70	10
<i>Sclerotinia fructicola</i>	100	100	100	100
<i>Stemphylium</i> sp.....	100	100	100	100

Vial test.—Additional tests were conducted using a variety of the fungicidal materials of this invention, a test termed the "vial test" being substituted for the agar plate test. The method is generally the same except that lid-equipped bottles of 1 oz. capacity were employed in place of the agar plates, thus allowing for the sealing in of the contents and careful control of the concentration of the fungicide in the presence of the fungus under treatment. Volatilization losses are prevented.

In testing compounds for fungitoxicity by this method, the compound is dispersed evenly through 10 ml. of liquid malt solution in the bottles. A series of bottles are prepared containing various concentrations of the compound for each fungus species. After treatment, each bottle is seeded with a few spores of the desired fungus. After seven days incubation in the dark at a temperature of 20° C., the fungus growth in each bottle is observed and the relationship between the growth in each bottle and that of the untreated but seeded control bottles is recorded as growth or control of the fungus.

Spore germination test.—This consists of placing 0.2 ml. of a series of concentrations of aqueous dispersions or solutions of the test fungicidal compound in individual microbeakers and then adding to each another 0.2 ml. of

forth below. These examples are by way of illustration and are not to be taken as imposing limitations on the scope of the invention other than as are set forth in the appended claims.

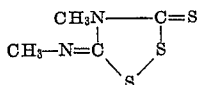
EXAMPLE I

In the laboratory preparation of N-1045, 330 g. (2.0 moles) of sodium N-methyl dithiocarbamate dihydrate (solid) were slurried with 500 cc. of ethanol. 256 g. (1.0 mole) of iodine were added with stirring in small increments. The reaction temperature was maintained at 10–20° C. by cooling in an ice bath. The reaction was practically instantaneous. After all of the iodine had been added, the reaction mixture was poured into 2 liters of water and filtered.

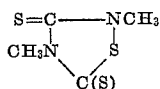
Yield—crude dimethyl thiuram disulfide, 210 g., 99 percent; M. P. 93° C.

Crystallization from methanol gave the pure dimethyl thiuram disulfide.

21 g. (0.1 mole) of freshly prepared dimethyl thiuram disulfide were slurried in 100 cc. of chloroform and chilled to 10° C. in an ice bath. 16 g. (0.1 mole) of Br₂ in 50 cc. of chloroform were added slowly maintaining the reaction temperature at 10–15° C. A reddish-brown ppt. was obtained. It was filtered off, washed with chloroform and then slurried with cold sodium bicarbonate solution. There was little reaction. The material was filtered off and slurried with ethanol and 28 percent ammonium hydroxide was added drop by drop until the mixture was alkaline. The ppt. was now filtered off. The product, the isomer of the desired material, was crystallized from cold chloroform by addition of ligroin. First crystallization, M. P. 72–76°; 2nd, 80–82°; 3rd, 84°; 4th (from benzene and ligroin), 84°. Yield, 6 g. or 33 percent of



3 g. of this isomer, M. P. 84° C., was boiled 5 minutes in isopropyl alcohol. The solution was chilled and allowed to crystallize. 2 g. of N-1045, M. P. 122–123° C., were obtained. The product has the formula:



EXAMPLE II

A solution of sodium N-methyl dithiocarbamate was concentrated by heating to approximately 70° C. and by placing the system under vacuum for several hours. Upon cooling the aqueous solution, a thick slurry of crystalline material was obtained. The product was centrifuged to remove the aqueous phase and the wet solid material was conveyed in air through a pneumatic conveying drier (flash drier) at approximately 150°–170° C. The product was then recycled through the flash drier at approximately 150° C.–170° C. The product warmed spontaneously on standing overnight and developed a strong isothiocyanate odor. The product was slurried in water, filtered, and the water-insoluble fraction was recrystallized from isopropyl alcohol as in Example I, to obtain N-1045, M. P. 122°–125° C. The filtrate containing the water-soluble fraction, which was mainly sodium N-methyl dithiocarbamate, was further concentrated under vacuum. The crystallization, cen-

trifugation, and flash drying steps were repeated to yield additional water-insoluble N-1045.

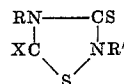
Fungicides of the present invention may be applied by methods well known to those skilled in the art. They may be used in solutions of organic solvents, such as acetone, dispersed in water, made into aerosols or mixed with a dry powder carrier for application to plants, animals or soil. They may be vaporized in confined spaces for their fumigation effect for protecting grain and the like. Solutions or emulsions may be used for spraying or dipping articles such as leather or cloth. A wide range of concentrations may be used, since the solutions of the compounds of the present invention are effective for some purposes, even in concentrations of less than one part per million.

In the claims hereinafter, reference is made to "material" which is protected from attack by fungus. It is to be understood that the term "material" includes plants, animals and inanimate objects which are subject to fungus attack.

Obviously many modifications and variations of the invention as hereinbefore set forth may be made without departing from the spirit and scope thereof, and therefore only such limitations should be imposed as are indicated in the appended claims.

We claim:

1. A method of protecting material from attack by fungus comprising applying thereto a small amount of the compound having the formula:



wherein R is a member of the class consisting of phenyl and alkyl groups, wherein R' is a member of the class consisting of phenyl and alkyl groups, and wherein X is a member of the class consisting of S and O.

2. A method of protecting material from fungus attack comprising applying thereto a small amount of 2,4-dimethyl-3,5-dithiono-1,4-thiadiazolidine.

3. A method of protecting material from fungus attack comprising applying thereto a small amount of 2,4-dimethyl-3-thiono-5-oxo-1,2,4-thiadiazolidine.

4. A method of protecting material from fungus attack comprising applying thereto a small amount of 2,4-diethyl-3,5-dithiono-1,2,4-thiadiazolidine.

5. A method of protecting material from fungus attack comprising applying thereto a small amount of 2,4-diethyl-3-thiono-5-oxo-1,2,4-thiadiazolidine.

6. A method of protecting material from fungus attack comprising applying thereto a small amount of 2,4-di-n-propyl-3-thiono-5-oxo-1,2,4-thiadiazolidine.

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