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PATENT SPECIFICATION

NO DRAWINGS

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COMPLETE SPECIFICATION

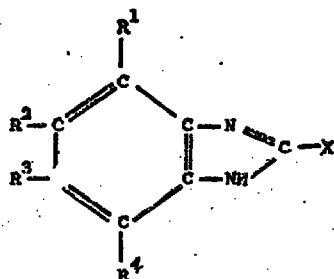
Fluorinated Benzimidazoles and Compositions containing them

We, FISONS PEST CONTROL LIMITED, a British Company, of Harston, Cambridgeshire, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to certain substituted benzimidazoles which have been found to possess physiological activity, to their preparation and to agricultural chemical and related compositions containing the same.

It has been found that the substituted benzimidazoles as hereinafter described are active in many fields and that certain members are highly active as herbicides, insecticides, molluscicides and fungicides.

Accordingly the present invention is for a physiologically active composition which contains as an active ingredient substituted benzimidazole of the following formula:—



and salts thereof, where in the above formula R^1 , R^2 , R^3 and R^4 may be the same or different and are selected from hydrogen, alkyl (for example 1—6 carbon atoms such as methyl, ethyl or propyl), hydroxy, alkoxy

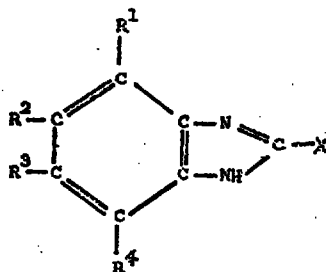
(for example methoxy, ethoxy or butoxy), nitro, halogen (for example chloro, bromo or fluoro), pseudo-halogen (for example cyano, thiocyno, isothiocyno or azido), substituted alkyl (for example trifluoromethyl, chloromethyl, bromomethyl, trichloromethyl, hydroxymethyl, 2-chloroethyl, 2-hydroxyethyl or 2-methoxyethyl), carboxy, carboxy ester, carboxy amide, N-substituted carboxy amide, N-disubstituted carboxy amide, amino or mono- or di-substituted amino (for example methylamino, dimethylamino, acetylamino, trifluoroacetylamino), thiol, alkylthiol and oxygenated derivatives thereof (for example $-\text{SOR}^5$ or $-\text{SO}_2\text{R}^5$ where R^5 is alkyl), sulphonic acid and esters and amides thereof, radicals and where X is trifluoromethyl or pentafluoroethyl, together with at least one material selected from wetting agents and solid inert diluents.

The present invention is also for a composition suitable for use as a molluscicide which comprises the substituted benzimidazole as identified above admixed with appropriate carrier. Appropriate carriers include solid diluents, edible substances attractive to molluscs and paints, for example suitable for marine application.

The present invention is also for the treatment of plants, the soil, land or aquatic areas, which comprises applying thereon or thereto a physiologically active composition as defined above.

The present invention is also for the salts of the substituted benzimidazoles of the formula indicated above as new compounds.

The present invention also comprises the new substituted benzimidazoles of the formula:—



- wherein R^1 , R^2 , R^3 , R^4 and X have the significance indicated above excluding those cases where X is trifluoromethyl and where
- 5 R^1 is hydrogen, methyl, trifluoromethyl, methoxy or carboxy, or where R^2 is fluoro, chloro, methyl, trifluoromethyl, methoxy or nitro, or where R^1 and R^2 are both methyl or trifluoromethyl, or where R^1 and R^4 are the same and are methyl or ethoxy, or where
 - 10 R^2 and R^3 are both methyl, when the remaining groups R^1 to R^4 are hydrogen, or where R^1 , R^2 , R^3 and R^4 are all fluoro groups, and excluding those cases where X is pentafluoroethyl and either where R^1 — R^4 are methyl and R^2 and R^3 are hydrogen.
 - 15

- Salts of the substituted benzimidazoles embraced by the present invention may comprise ammonium salts, metal salts such as for
- 20 example sodium, potassium, calcium, zinc, copper and magnesium salts, amine salts such as for example methylamine, ethylamine, dimethylamine, triethylamine, ethanolamine, triethanolamine and benzylamine salts.
 - 25 According to a preferred embodiment the salts are alkali metal salts. Generally the alkali metal salts are crystalline solids, readily soluble in water.

- The salts may be prepared by reacting
- 30 the benzimidazole in aqueous or aqueous-organic solvent solution or suspension with an alkaline compound of the metal, such as the hydroxide, or with the amine, as appropriate. The metal salts may also be prepared by metathesis for example between the alkali metal salt of the benzimidazole and a salt of the metal. Some of the benzimidazoles are also basic and can form salts with strong acids such as hydrochloric acid.
 - 35

- It has been found that the substituted benzimidazoles according to the invention generally possess physiological activity. Many of these compounds are useful as herbicides having post-emergent activity as well as some
- 40 pre-emergent activity, or as insecticides, or as molluscicides, or as fungicides.
 - 45

New substituted benzimidazoles according to the present invention which may be mentioned include:—

- 50 4,5,6,7 - tetrachloro - 2 - trifluoromethylbenzimidazole
- 4,5,6 - trichloro - 2 - trifluoromethylbenzimidazole

- 4,5,7 - trichloro - 2 - trifluoromethylbenzimidazole 55
- 4,5 - dichloro - 2 - trifluoromethylbenzimidazole
- 4,6 - dichloro - 2 - trifluoromethylbenzimidazole 5
- 4,7 - dichloro - 2 - trifluoromethylbenzimidazole 60
- 4 - nitro - 6 - chloro - 2 - trifluoromethylbenzimidazole 19
- 4 - chloro - 6 - nitro - 2 - trifluoromethylbenzimidazole 65
- 4 - chloro - 2 - trifluoromethylbenzimidazole
- 4 - bromo - 5,6,7 - trichloro - 2 - trifluoromethylbenzimidazole 15
- 4,6,7, - trichloro - 5 - methyl - 2 - trifluoromethylbenzimidazole 70
- 4,5,6 - trichloro - 2 - pentafluoroethylbenzimidazole 20
- 5 - nitro - 2 - pentafluoroethylbenzimidazole. 75

According to one embodiment of the invention, the substituted benzimidazoles as indicated are prepared by reacting the corresponding ortho-phenylenediamine with trifluoroacetic acid, trifluoro acetyl chloride or trifluoro acetic anhydride, or with pentafluoropropionic acid, pentafluoropropionyl chloride or pentafluoropropionic anhydride.

Many of the salts of the substituted benzimidazoles embraced by the invention are water-soluble, and these may be used in physiologically active compositions as aqueous solutions with or without wetting or dispersing agents, organic solvents or stickers which are commonly incorporated in sprays for agricultural and related purposes. However it is generally preferred to use the salts of the substituted benzimidazole in association with a wetting agent.

If desired the substituted benzimidazoles or salts thereof may be dissolved in a water immiscible solvent, such as for example a high boiling hydrocarbon, suitably containing dissolved emulsifying agents so as to act as a self-emulsifiable oil on addition to water.

The substituted benzimidazoles or salts thereof may also be admixed with a wetting agent with or without an inert diluent to form a wettable powder which is soluble or dispersible in water, or may be mixed with the inert diluent to form a solid or powdery product.

Inert diluents with which the substituted benzimidazoles and salts thereof may be incorporated include solid inert media comprising powdered or divided solid materials, for example, clays, sands, talc, mica or fertilizers, such products either comprising dust or larger particle size materials.

The wetting agents used may comprise anionic compounds such as for example soaps,

fatty sulphate esters such as dodecyl sodium sulphate, fatty aromatic sulphonates such as alkyl-benzene sulphonates or butyl naphthalene sulphonate, more complex fatty sulphonates such as the amide condensation product of oleic acid and N-methyl taurine or the sodium sulphonate of dioctyl succinate.

The wetting agents may also comprise non-ionic wetting agents such as for example condensation products of fatty acids, fatty alcohols or fatty substituted phenols with ethylene oxide, or fatty esters and ethers of sugars or polyhydric alcohols, or the products obtained from the latter by condensation with ethylene oxide, or the products known as block copolymers of ethylene oxide and propylene oxide. The wetting agents may also comprise cationic agents such as for example cetyl trimethylammonium bromide.

For molluscicidal use the benzimidazole may for example be made into a granule or pellet, for example a plaster of paris, which may be scattered in an aquatic habitat of the molluscs, and from which the benzimidazole may be leached, or dissolved into a spreading oil such as diesel or lubricating oil with a wetting agent such as oleic acid, which may be applied to the water surface. The present invention also comprises a process for the treatment of water to purify this by the destruction of aquatic molluscs which comprises adding to the water the benzimidazoles according to the invention.

Edible substances attractive to molluscs with

which the benzimidazoles may be admixed include fungi, oil-cake, fruit waste, lucerne flour, cereals, cereal products, vegetables, vegetable products, bran and biscuits.

The physiologically active compositions according to the present invention may contain in addition to the substituted benzimidazole or salts thereof, other physiologically active materials such as herbicides, insecticides, fungicides and molluscicides.

The following examples are given to illustrate the present invention; the parts and percentages are by weight unless otherwise indicated.

EXAMPLE 1

50 Parts of 3,4,5,6 - tetrachloro - o - phenylenediamine and 62 parts of trifluoroacetic acid were heated for 16 hours at 100°C with protection from the ingress of moisture. The excess trifluoroacetic acid and the water formed in the reaction were then removed under reduced pressure and the final traces removed by keeping over solid sodium hydroxide under high vacuum. The residual solid cake was powdered and heated with 3500 parts of boiling benzene. The boiling solution was filtered from a small amount of insoluble material treated with charcoal and set aside to crystallise. The product 4,5,6,7 - tetrachloro - 2 - trifluoromethylbenzimidazole (33.3 parts; 50% yield, separated as fine needles, melting point 285°C, unchanged by further recrystallization.

Analysis:

Found : C, 30.90; H, 0.30; Cl, 43.0; F, 17.10; N, 8.55
 $C_8HCl_4F_3N_2$ requires: C, 29.66; H, 0.31; Cl, 43.78; F, 17.60; N, 8.65%.

EXAMPLE 2

Using the same method as described in the preceding example 3,4,5 - trichloro - o - phenylene diamine on reaction with trifluoroacetic acid gave 4,5,6 - trichloro - 2 - trifluoromethylbenzimidazole which was purified by dissolving the reaction mixture in an

excess of 10% aqueous sodium hydroxide solution and precipitation with dilute hydrochloric acid. The dried precipitate was recrystallised from toluene with the aid of charcoal. The colourless product (53% yield) had melting point 226—228°C.

Analysis:

Found : C, 33.35; H, 0.90; N, 9.80; Cl, 36.50; F, 20.0
 $C_8H_2Cl_3F_3N_2$ requires: C, 33.19; H, 0.69; N, 9.68; Cl, 36.74; F, 19.69%

EXAMPLE 3

3,5,6 - Trichloro - o - phenylenediamine was reacted with trifluoroacetic acid, using the same method as described in Example 1, to give 4,5,7 - trichloro - 2 - trifluoromethyl-

benzimidazole, which was purified in an identical manner to Example 2 and the colourless product (66% yield) had melting point 240—242°C.

Analysis:

Found : N, 9.85; Cl, 36.45; F, 19.45
 $C_8H_2Cl_3F_3N_2$ requires: N, 9.68; Cl, 36.74; F, 19.69%.

EXAMPLE 4

17.6 Parts of 3,4 - dichloro - o - phenylene diamine were heated overnight in a steam bath with 10 parts of trifluoroacetic acid.

The ingress of moisture was prevented by use of a calcium chloride guard tube. The

reaction mixture was then dissolved in 250 parts of a 10% sodium hydroxide solution which was then filtered to remove any insoluble material. By acidification of the alkaline filtrate, a red-brown solid was obtained, which was filtered off, washed with

water and dried. The dried solid (23.5 parts) was then crystallised from 75% ethanol (charcoal) to yield 4,5 - dichloro - 2 - tri-

fluoromethyl benzimidazole as an off-white solid (17 parts; 62% yield), melting point 213—4°C. 5

Analysis:

Found : C, 37.95; H, 1.25; N, 11.05; Cl, 27.55
 $C_6H_2Cl_2F_3N_2$ requires: C, 37.67; H, 1.19; N, 10.98; Cl, 27.81%.

10 EXAMPLES 5—16

In an analogous manner to Example 4 the following compounds were prepared:—

- 15 4,6 - dichloro - 2 - trifluoromethylbenzimidazole (melting point 175—7°C)
- 15 4,7 - dichloro - 2 - trifluoromethylbenzimidazole (melting point 273—4°C)
- 4 - nitro - 6 - chloro - 2 - trifluoromethylbenzimidazole (m.p. 148—150°C)
- 20 4 - chloro - 6 - nitro - 2 - trifluoromethylbenzimidazole (melting point 206—8°C)
- 5,6 - dichloro - 2 - trifluoromethylbenzimidazole (melting point 244—5°C)
- 4 - bromo - 5,6,7 - trichloro - 2 - trifluoromethylbenzimidazole (m.p. 260—2°C)
- 25 4 - chloro - 2 - trifluoromethylbenzimidazole (melting point 159—161°C)
- 5,6 - dimethoxy - 2 - trifluoromethylbenzimidazole hydrochloride (melting point 211—212°C)
- 30 5,6 - dinitro - 2 - trifluoromethylbenzimidazole (melting point 242—243°C)
- 4,7 - dibromo - 2 - trifluoromethylbenzimidazole (melting point 267—0°C)
- 35 5 - cyano - 2 - trifluoromethylbenzimidazole (melting point 192°C)

Analysis:

Found : N, 8.75; Cl, 32.40
 $C_6H_2Cl_3F_3N_2$ requires: N, 8.50; Cl, 32.28%.

- 65 The following compounds were prepared in an analogous way:—

- 5 - nitro - 2 - pentafluoroethylbenzimidazole (melting point 140—1°C)
- 70 4 - nitro - 6 - chloro - 2 - pentafluoroethylbenzimidazole (m.p. 113—5°C)
- 4,6,7 - trichloro - 5 - methyl - 2 - pentafluoroethylbenzimidazole (melting point 260—5°C).

EXAMPLE 21

- 75 A herbicidal composition was prepared by grinding together 100 parts of 5 - nitro - 2 - trifluoromethylbenzimidazole, 200 parts of chalk and 50 parts of sorbitan mono-oleate, forming a wettable powder. The wettable powder was dispersed in water for spraying purposes and was used as a post-emergent selective herbicide at a rate of 5 ounces per acre.

EXAMPLE 22

- 85 A herbicidal composition was made by preparing an aqueous concentrate of the sodium salt of 5 - chloro - 2 - trifluoromethyl benzimidazole and Lissapol NX (Registered Trade

4,6,7 - trichloro - 5 - methyl - 2 - trifluoromethylbenzimidazole (sublimes above 145°C).

EXAMPLES 17—20

16.4 Parts of pentafluoropropionic acid 40 were added to 10.5 parts of 3,4,5 - trichloro - o - phenylene diamine and the mixture heated for 15 hours on a steam bath. The solid cake formed was stirred with 10% aqueous sodium hydroxide solution and insoluble unreacted 45 diamine filtered off. The alkaline liquor was made almost neutral by the addition of concentrated hydrochloric acid and then made just acid by the addition of glacial acetic acid. The brown oil obtained was extracted 50 into benzene and the liquor clarified with charcoal. The benzene liquor was extracted with 0.880 ammonia and the alkaline extract neutralised with concentrated hydrochloric acid and made just acid with glacial acetic acid. 55

The precipitated product was filtered off and recrystallised from toluene to give 4,5,6 - trichloro - 2 - pentafluoroethylbenzimidazole in a yield of 4 parts (25%), melting point 206—7.5°C. 60

Mark). This aqueous concentrate could be diluted with further water for spraying. 90

EXAMPLE 23

Peas, mustard, linseed, buckwheat, sugar-beet, barley, mayweed and chickenweed were grown in John Innes No. 1. potting compost in aluminium pans ($7\frac{1}{2}'' \times 3\frac{3}{4}'' \times 2''$), two species to a pan. When the plants had 95 between 2 and 5 true leaves they were sprayed with an aqueous solution of the sodium salt of benzimidazole indicated in the following table at rates equivalent to 160, 80, 40, 20, 10, 5 and $2\frac{1}{2}$ ounces per acre in 40 gallons. 100

After seven days in a controlled environment room at 22°C with 14 hours/day illumination of 800 feet candles and at 75—90% relative humidity, the plants were 105 assessed for any herbicidal effect.

The herbicidal effect of the compounds was assessed as an average for the eight species, on a scale where 100 indicates complete kill and 0 indicates no herbicidal 110 activity. The results are given in the following table:—

Rate

4,5-dichloro-2-
 4,6-dichloro-2-
 4-nitro-6-chloro-
 4-chloro-6-nitro-
 4,5,6,7-tetrachloro-
 4,5,6-trichloro-
 4,5,7-trichloro-
 5-chloro-2-trifluoro-
 4-chloro-2-trifluoro-
 2,5-bis(trifluoro-
 5-nitro-2-trifluoro-
 4,5,6-trichloro-
 5-nitro-2-pentafluoro-

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Compound	Average toxicity						
	160	80	40	20	10	5	2½
Rates in ounce/acre							
4,5-dichloro-2-trifluoromethylbenzimidazole	84	81	79	72	57	53	
4,6-dichloro-2-trifluoromethylbenzimidazole	98	97	96	93	88	74	57
4-nitro-6-chloro-2-trifluoromethylbenzimidazole	96	96	96	95	89	76	72
4-chloro-6-nitro-2-trifluoromethylbenzimidazole	94	93	93	86	84	81	
4,5,6,7-tetrachloro-2-trifluoromethylbenzimidazole	72	71	66	62	53		
4,5,6-trichloro-2-trifluoromethylbenzimidazole	100	96	96	94	89	84	61
4,5,7-trichloro-2-trifluoromethylbenzimidazole	89	84	75	73	71	67	70
5-chloro-2-trifluoromethylbenzimidazole	86	78	76	65	58		
4-chloro-2-trifluoromethylbenzimidazole	93	87	82	67	66		
2,5-bis(trifluoromethyl)benzimidazole	95	88	80	79	74	49	
5-nitro-2-trifluoromethylbenzimidazole	95	73	66	62	60	57	
4,5,6-trichloro-2-pentafluoroethylbenzimidazole	94	94	93	91	90	78	51
5-nitro-2-pentafluoroethylbenzimidazole	96	93	91				

EXAMPLE 24

Peas, mustard, linseed, maize, barley and ryegrass seed sown in John Innes No. 1 potting compost in which 5 - nitro - 2 - trifluoromethylbenzimidazole had been incorporated at rates equivalent to 24 and 12 parts per million weight/volume of soil or equivalent to a surface application of 10 and 5 pounds per acre. The plants were grown in aluminium pans (7½ inches × 3½ inches × 2 inches), one species to a pan.

After 21 days growth in a controlled environment room the plants were assessed for any herbicidal effects when it was found that the germination of mustard and linseed had been suppressed by both rates, the germination of ryegrass had been severely suppressed and the surviving plants were markedly stunted and incapable of normal growth, whilst peas, barley and maize were relatively unaffected.

EXAMPLE 25

Solutions containing 10, 3, 1, 0, 3 and 0.1 parts per million (weight by volume) of the compounds listed below were made in aerated distilled water. 100 millilitres aliquots of the solutions were placed in screw cap glass jars, 4.5 centimetres diameter by 8.5 centimetres high, which just filled them to the brim. Five young specimens of the bilharzia vector snail, *Australorbis glabratus*, were then placed in each vessel and a perforated lid screwed on to prevent them leaving the water. After a 24 hour exposure period the snails were removed from the solutions of the compounds and placed in aerated distilled water for a further 48 hours recovery period, before an assessment of mortality was made.

The results obtained are summarised in the following table, each value being the average of three replications.

Compound	% mortality after 72 hours				
	10 ppm	3 ppm	1 ppm	0.3 ppm	0.1 ppm
1. 4-bromo-5,6,7-trichloro-2-trifluoromethylbenzimidazole	100	100	100	100	50
2. 4,6,7-trichloro-5-methyl-2-trifluoromethylbenzimidazole	100	100	60	50	0
3. 4,5-dichloro-2-trifluoromethylbenzimidazole	100	100	100	0	0
4. 4-nitro-6-chloro-2-trifluoromethylbenzimidazole	100	100	100	0	0
5. 4,5,6-trichloro-2-trifluoromethylbenzimidazole	100	100	100	30	0
6. 4,6,7-trichloro-2-trifluoromethylbenzimidazole	100	100	60	0	0
7. 4,5,6,7-tetrachloro-2-trifluoromethylbenzimidazole	100	100	80	0	0

These results indicate that each compound possesses a marked molluscicidal activity.

EXAMPLE 26

5 An insecticidal composition was prepared by grinding together 100 parts of 4,7-dichloro-2-trifluoromethylbenzimidazole, 200 parts of chalk and 50 parts of sorbitan monooleate forming a wettable powder. This wettable powder was dispersed in water and sprayed or painted onto walls giving a long residual insecticidal effect.

EXAMPLE 27

15 A molluscicidal composition was prepared by admixing 100 parts of diesel oil, 5 parts of 4-bromo-5,6,7-trichloro-2-trifluoromethylbenzimidazole and 2 parts of oleic acid so as to form an oil solution. This oil was sprayed onto water surfaces and spread over the water allowing the active ingredient to dissolve therein.

EXAMPLE 28

25 9 Centimetres diameter filter papers in 9 centimetres crystallising dishes were treated with 1 millilitre portions of acetone solutions of 4,7-dichloro-2-trifluoromethylbenzimidazole at concentrations giving deposits equivalent to 1087, 108.7, 10.87 and 5.44 mg/square metre. Batches of female house flies (*Musca domestica*) lightly anaesthetised with carbon dioxide, were introduced

into the dishes after the solvent had evaporated, and a glass lid was placed over each dish. After 24 hours the dishes were examined and it was found that there was a complete kill of flies at all four concentrations. Flies maintained under similar conditions in the absence of the chemical were unaffected.

EXAMPLE 29

40 11 Grams of 3-amino-5-mercapto-ortho-phenylenediamine dihydrochloride were refluxed for eight hours with 12 millilitres of trifluoroacetic acid. The solid product comprising 2-trifluoromethyl-4-trifluoroacetamido-6-mercapto benzimidazole was filtered off, washed with a little trifluoroacetic acid and recrystallised from benzene giving 4 grams of the crystalline product of melting point 229—231°C.

EXAMPLE 30

50 Nutrient medium known as potato-dextrose agar medium was made up in molten condition with incorporation of compounds of the invention at various concentration levels. The medium was then allowed to set in petri dishes and plugs of actively growing mycelium of the fungi listed below were placed on the plates. The concentrations which were found to restrict growth to (a) 50% (b) 95% that observed in control plates are recorded.

	5-Chloro-2-trifluoromethyl benzimidazole		4,5,6-trichloro-2-trifluoromethyl benzimidazole	
	50%	95%	50%	95%
<i>Phytophthora palmivora</i>	<10	<10	<10	10
<i>Alternaria solani</i>	<10	20	<10	20
<i>Botrytis fabae</i>	<10	<10	<10	10
<i>Fusarium oxysporum</i>	<10	47	<10	29
<i>Verticillium albo atrum</i>	<10	13	<10	30
<i>Fomes annosus</i>	<10	<10	<10	<10

EXAMPLE 31

5 The compound 4,5,7 - trichloro - 2 - trifluoromethyl benzimidazole was ground in presence of equal weight of china clay and 10% of sorbitan mono oleate to give a wettable powder and this was suspended in water to give various concentrations of active ingredients and then sprayed to run-off on

10 cucumber leaves which were subsequently dusted with spores of the mildew *Erysiphe cichoracearum*. Development of the fungus in comparison with that on untreated leaves is recorded.

Concentrations ppm	% developed	
500	3	15
250	10	
125	30	
62	55	
31	90	20

EXAMPLE 32

25 Parts of 4,5,6 - trichloro - 2 - trifluoromethyl benzimidazole, 3.35 parts of sodium hydroxide and 100 parts of water were found to form a clear aqueous solution of the sodium salt which did not deposit crystals above 0°C. This solution was evaporated and on cooling crystalline 4,5,6 - trichloro - 2 - trifluoromethyl benzimidazole, sodium salt, was obtained.

30

Analysis :

Found : C, 30.75; H, 0.39; N, 9.06; Cl, 33.98; F, 18.16; Na, 7.42%
 $C_8H_2N_2Cl_3F_3Na$ req.: C, 30.85; H, 0.32; N, 9.0; Cl, 34.16; F, 18.30; Na, 7.38%.

EXAMPLE 33

35 30 Parts of 2,5 - di(trifluoromethyl)benzimidazole, 30 parts of industrial ethyl alcohol, 4.8 parts of sodium hydroxide and 80 parts

of water were found to form a clear aqueous solution which on cooling deposited crystals of the sodium salt.

40

Analysis:

Found : F, 41.10; Na, 8.45%
 $C_8H_3F_6N_2Na$ requires: F, 41.29; Na, 8.33%.

EXAMPLE 34

45 29 Parts of 4,5,7 - trichloro - 2 - trifluoromethyl benzimidazole were dissolved with agitation in 100 parts of a 10% solution of trimethylamine in water giving an aqueous solution of the trimethylamine salt of 4,5,7 - trichloro - 2 - trifluoromethyl benzimidazole.

50

EXAMPLE 35

22 Parts of 5 - chloro - 2 - trifluoromethyl benzimidazole, 6 parts of potassium hydroxide, 30 parts of methyl alcohol, and 70 parts of water were heated together giving a clear solution which on partial evaporation and cooling deposited crystals of the potassium salt of 5 - chloro - 2 - trifluoromethyl benzimidazole.

55

60

Analysis:

Found : C, 37.21; H, 1.19; N, 10.86; Cl, 13.93; K, 14.77%.
 $C_8H_5ClF_3N_2K$ req.: C, 37.15; H, 1.17; N, 10.83; Cl, 13.89; K, 15.09%.

EXAMPLE 36

5 23.1 Grams of 5 - nitro - 2 - trifluoromethylbenzimidazole were dissolved in 250 millilitres of absolute alcohol, Adams platinum catalyst was added and hydrogen passed through until 3 mols of hydrogen had been
 10 absorbed and the solution which was initially red-brown turned green. The alcohol was removed by vacuum distillation at 80°C to give a black oily residue, which was dissolved

in 40 millilitres of anhydrous ether and dry hydrogen chloride gas was passed through until precipitation was complete. The solid was filtered off, washed with ether, dried and recrystallised from concentrated hydrochloric acid to give 20 grams of 5 - amino - 2 - trifluoromethylbenzimidazole dihydrochloride. (Melting point 262°C with decomposition).

Analysis:

Found : C, 34.80; H, 3.05; Cl, 25.75; N, 15.40%.
 $C_8H_5Cl_2F_3N_3$ requires: C, 35.04; H, 2.92; Cl, 25.91; N, 15.33%.

EXAMPLE 37

To a mixture of 15.5 grams of 4,5,6 - trichloro - 2 - trifluoromethylbenzimidazole and 9 millilitres of concentrated sulphuric acid
 30 were added 18 millilitres of fuming nitric acid in 1 millilitre portions. When the initial reaction had subsided the mixture was refluxed on an oil bath for 1 hour. The mixture was cooled and poured onto ice, the
 35 precipitate filtered off, washed with water

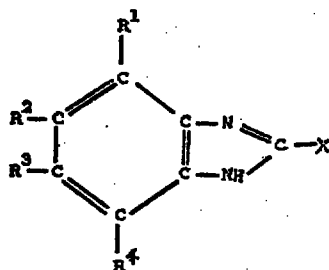
and added to excess caustic soda solution. The resulting solution was filtered and the filtrate neutralised with hydrochloric acid and acetic acid, and the resulting precipitate
 40 filtered off, washed with water, dried and recrystallised from benzene giving 12.8 grams of 4,5,6 - trichloro - 7 - nitro - 2 - trifluoromethylbenzimidazole (melting point 221—223°C).

Analysis:

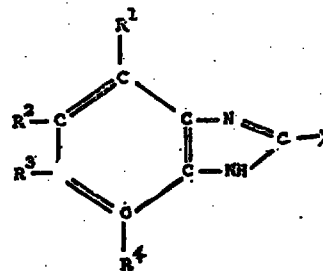
Found : C, 28.80; H, 0.30; Cl, 31.35; N, 12.55%.
 $C_8HCl_3F_3N_3O_2$ requires: C, 28.73; H, 0.30; Cl, 31.79; N, 12.56%.

4,6,7 - Trichloro - 5 - nitro - 2 - trifluoromethylbenzimidazole (melting point 225°C)
 50 was prepared in a similar way.

According to a further embodiment, the present invention is for compounds of the formula:—



55 and salts thereof, where R^1 , R^2 , R^3 , R^4 and X have the significance indicated herein, but where at least one of the groups R^1 , R^2 , R^3 and R^4 is chlorine and not more than two of the groups R^1 , R^2 , R^3 and R^4 are hydrogen.
 60 According to a yet further embodiment, the present invention is for compounds of the formula:—



and salts thereof, where R^1 , R^2 , R^3 , R^4 and X have the significance indicated herein, but where at least one of the groups R^1 , R^2 , R^3 , and R^4 is cyano, amino, substituted amino or a mercapto group.

According to a further embodiment of the invention, the substituted benzimidazoles bearing an amino group are prepared by the reduction of the corresponding nitro substituted benzimidazole.

According to a yet further embodiment of the invention, the substituted benzimidazoles bearing nitro groups together with other substituents such as halogen are prepared by nitration of the corresponding substituted benzimidazole.

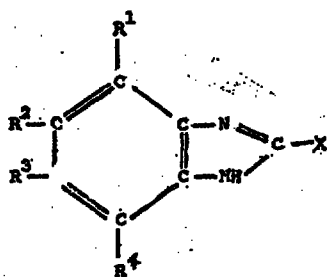


1,087,561

9

WHAT WE CLAIM IS:—

1. A physiologically active composition which contains as an active ingredient a substituted benzimidazole of the following formula:—



and salts thereof, where in the above formula X is trifluoromethyl or pentafluoroethyl, and R¹, R², R³ and R⁴ are the same or different and selected from hydrogen, alkyl, hydroxy, alkoxy, nitro, halogen, pseudo-halogen, substituted alkyl, carboxy, carboxy ester, carboxy amide, N-substituted carboxy amide, N-disubstituted carboxy amide, amino or mono- or di-substituted amino, thiol, alkylthiol and oxygenated derivatives thereof, sulphonic acid, ester and amide, radicals, together with at least one material selected from wetting agents and solid inert diluents.

2. A physiologically active composition as claimed in claim 1 specially suited for use as a molluscicide which contains at least one material selected from the group comprising solid diluents, edible substances attractive to molluscs and paints.

3. A physiologically active composition as claimed in claim 1 which contains as active ingredient a compound selected from 4,5,6,7-tetrachloro - 2 - trifluoromethylbenzimidazole, 4,5,6 - trichloro - 2 - trifluoromethylbenzimidazole, 4,5,7 - trichloro - 2 - trifluoromethylbenzimidazole, 5 - chloro - 2 - trifluoromethylbenzimidazole, 4,5 - dichloro - 2 - trifluoromethylbenzimidazole, 4,6 - dichloro - 2 - trifluoromethylbenzimidazole, 4,7 - dichloro - 2 - trifluoromethylbenzimidazole, 4 - nitro - 6 - chloro - 2 - trifluoromethylbenzimidazole, 4 - chloro - 6 - nitro - 2 - trifluoromethylbenzimidazole, 4 - chloro - 2 - trifluoromethylbenzimidazole, 5 - nitro - 2 - trifluoromethylbenzimidazole, 4 - bromo - 5,6,7 - trichloro - 2 - trifluoromethylbenzimidazole, 4,6,7 - trichloro - 5 - methyl - 2 - trifluoromethylbenzimidazole, 2,5 - bis(trifluoromethyl)benzimidazole, 4,5,6 - trichloro - 2 - pentafluoroethylbenzimidazole and 5 - nitro - 2 - pentafluoroethylbenzimidazole.

4. Physiologically active compositions substantially as hereinbefore described.

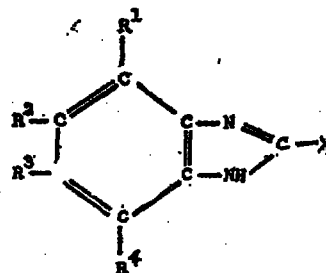
5. A physiologically active composition as claimed in any of the preceding claims 1—4 which is a herbicidal composition.

6. A herbicidal composition as claimed

in claim 5 which contains as an active ingredient 4,5 - dichloro - 2 - trifluoromethylbenzimidazole.

7. A process for the treatment of plants, the soil, land or aquatic areas, which comprises applying thereon or thereto a physiologically active composition as claimed in any of claims 1—4, or a salt or a compound as claimed in claim 8 or claim 11.

8. As new compounds the salts of substituted benzimidazoles of the formula:—

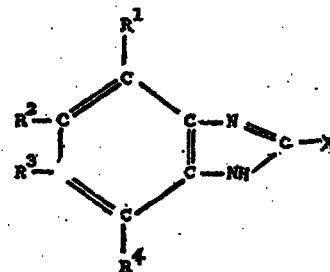


where in the above formula X is trifluoromethyl or pentafluoroethyl, and R¹, R², R³ and R⁴ are the same or different and selected from hydrogen, alkyl, hydroxy, alkoxy, nitro, halogen, pseudo-halogen, substituted alkyl, carboxy, carboxy ester, carboxy amide, N-substituted carboxy amide, N-disubstituted carboxy amide, amino or mono- or di-substituted amino, thiol, alkylthiol and oxygenated derivatives thereof, sulphonic acid, ester and amide, radicals.

9. Compounds as claimed in claim 8 comprising the ammonium salts, metal salts and amine salts.

10. Compounds as claimed in claim 8 comprising the alkali metal salts.

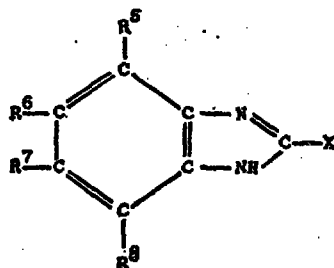
11. As new compounds the substituted benzimidazoles of the formula:—



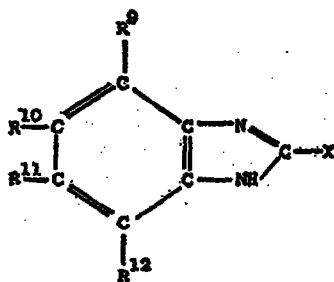
where in the above formula X is trifluoromethyl or pentafluoroethyl, and R¹, R², R³ and R⁴ are the same or different and selected from hydrogen, alkyl, hydroxy, alkoxy, nitro, halogen, pseudo-halogen, substituted alkyl, carboxy, carboxy ester, carboxy amide, N-substituted carboxy amide, N-disubstituted carboxy amide, amino or mono- or di-substituted amino, thiol, alkylthiol and oxygenated derivatives thereof, sulphonic acid, ester and amide, radicals, excluding the cases



- where X is trifluoromethyl and where R¹ is hydrogen, methyl, trifluoromethyl, methoxy or carboxy, or where R² is fluoro, chloro, methyl, trifluoromethyl, methoxy or nitro, or where R¹ and R² are both methyl or trifluoromethyl, or where R¹ and R⁴ are the same and are methyl or ethoxy, or where R² and R³ are both methyl, when the remaining groups R¹ to R⁴ are hydrogen, or where R¹, R², R³ and R⁴ are all fluoro groups, and excluding those cases where X is pentafluoroethyl and either where R¹ to R⁴ are all hydrogen or fluorine or where R¹ and R⁴ are methyl and R² and R³ are hydrogen.
12. As new compounds the substituted benzimidazoles of the formula:—



- and salts thereof, where in the above formula X is trifluoromethyl or pentafluoromethyl and R⁵, R⁶, R⁷ and R⁸ are the same or different and selected from hydrogen, alkyl, hydroxy, alkoxy, nitro, halogen, pseudo-halogen, substituted alkyl, carboxy, carboxyester, carboxyamide, N-substituted carboxyamide, N-disubstituted carboxyamine, amino or mono- or di-substituted amino, thiol, alkylthiol and oxygenated derivatives thereof, and sulphonic acid, ester and amide, radicals, where at least one of the groups R⁵, R⁶, R⁷ and R⁸ is chlorine and not more than two of the groups R⁵, R⁶, R⁷ and R⁸ are hydrogen.
13. As new compounds the substituted benzimidazoles of the formula:—



- and salts thereof, where in the above formula X is trifluoromethyl or pentafluoromethyl and R⁹, R¹⁰, R¹¹ and R¹² are the same or different and selected from hydrogen, alkyl, hydroxy, alkoxy nitro, halogen, pseudo-halogen, sub-

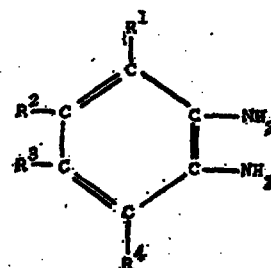
stituted alkyl, carboxy, carboxy-ester, carboxyamide, N-substituted carboxy amide, N-disubstituted carboxy amide, amino or mono- or di-substituted amino, thiol, alkylthiol and oxygenated derivatives thereof, and sulphonic acid, ester and amide, radicals, where at least one of the groups R⁹, R¹⁰, R¹¹ and R¹² is cyano, amino, substituted amino or a mercapto group.

14. As new compounds any of the following compounds: 4,5,6,7 - tetrachloro - 2 - trifluoromethylbenzimidazole, 4,5,6 - trichloro - 2 - trifluoromethylbenzimidazole, 4,5,7 - trichloro - 2 - trifluoromethylbenzimidazole, 4,5 - dichloro - 2 - trifluoromethylbenzimidazole, 4,6 - dichloro - 2 - trifluoromethylbenzimidazole, 4,7 - dichloro - 2 - trifluoromethylbenzimidazole, 4 - nitro - 6 - chloro - 2 - trifluoromethylbenzimidazole, 4 - chloro - 6 - nitro - 2 - trifluoromethylbenzimidazole, 4 - chloro - 2 - trifluoromethylbenzimidazole, 4 - bromo - 5,6,7 - trichloro - 2 - trifluoromethylbenzimidazole and 4,6,7 - trichloro - 5 - methyl - 2 - trifluoromethylbenzimidazole.

15. A process for the preparation of a substituted benzimidazole as claimed in claim 13 wherein at least one of the groups R⁹ to R¹² is an amino group, which comprises reducing the corresponding nitro-substituted benzimidazole.

16. A process for the preparation of a substituted benzimidazole as claimed in claim 11 wherein at least one of the groups R¹ to R⁴ is nitro, and not more than two of the groups R¹ to R⁴ being hydrogen, which comprises nitrating the corresponding substituted benzimidazole which is free from nitro groups.

17. A process for the preparation of substituted benzimidazoles as claimed in claim 11 which comprises reacting the corresponding diamine of the formula:—



wherein R¹, R², R³ and R⁴ have the significance indicated in claim 11, with trifluoroacetic acid, trifluoroacetyl chloride, trifluoroacetic anhydride, pentafluoropropionic acid, pentafluoropropionyl chloride or pentafluoropropionic anhydride.

18. 4,5 - Dichloro - 2 - trifluoromethyl benzimidazole.

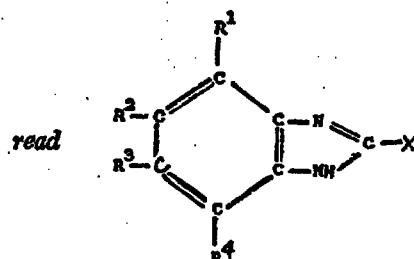
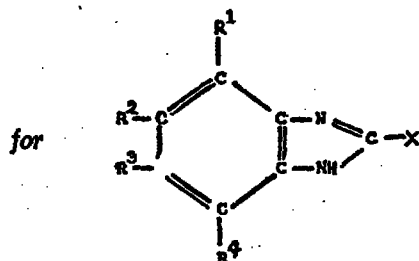
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ERRATA

SPECIFICATION No. 1,087,561

Pages 1, 8 and 9, Formulae,



Page 1, line 49, for "molluscicide" read "molluscicide"

Page 2, line 15, after "are" insert "all hydrogen or fluorine or where R¹ and R⁴ are"

Page 3, line 20, for "molluscicidal" read "molluscicidal"

Page 3, line 44, for "molluscicides" read "molluscicides"

Page 4, line 93, for "chickenweed" read "chickweed"

Page 5, line 32, for "Australorbic" read "Australorbis"

Page 6, line 25, for "millilitre" read "millimetre"

Page 7, Table, 1st column, line 1, for "Phytophthora" read "Phytophthora"

Page 7, Table, 1st column, line 3, for "Botrytis" read "Botrytis"

Page 7, Table, 1st column, line 5, for "Verticillium" read "Verticillium"

Page 10, line 25, for "carboxyamine" read "carboxamide"

Page 10, lines 39 and 40, for "substituted" read "substituted"

THE PATENT OFFICE
20th November 1967

