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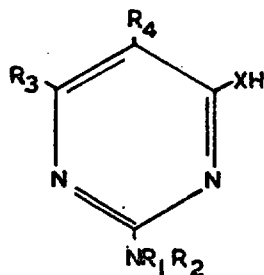
(54) SALTS OF PYRIMIDINE DERIVATIVES AND THE USE THEREOF AS FUNGICIDES

(71) We, IMPERIAL CHEMICAL INDUSTRIES LIMITED, a British Company, of Imperial Chemical House, Millbank, London, S.W.1, 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:—

This invention relates to fungicidal compositions containing as an active ingredient a salt of a pyrimidine derivative, to new salts of pyrimidine derivatives, to processes for making new salts of pyrimidine derivatives and to methods for combating plant fungal diseases.

In our co-pending application No. 14271/66 (U.K. patent no. 1,182,584) we have described fungicidal compositions comprising, as an active ingredient, a pyrimidine derivative. The present invention includes fungicidal compositions comprising, as an active ingredient, a salt of a pyrimidine derivative therein set forth.

According to the invention we provide a fungicidal composition comprising as an active ingredient an acid addition salt or a metal salt of a pyrimidine derivative of the formula:—



or an acid addition salt of an ether thereof,

wherein R₁ and R₂ are:

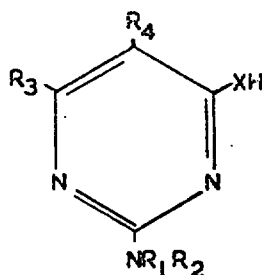
- hydrogen,
- a substituted or unsubstituted hydrocarbon,
- a heterocyclic ring,
- a benzyldine-imino group,
- an amino or sulphur-free substituted amino group,
- a cyano group,
- a substituted or unsubstituted carbamoyl group,
- an R-CO— or R-SO₂— group where R is a substituted or unsubstituted hydrocarbon group,

or R₁ and R₂, together with the adjacent N-atom form a substituted or unsubstituted heterocyclic ring which may contain one or more additional heterocyclic atoms; and wherein R₃ and R₄ are:

- hydrogen
- halogen
- a substituted or unsubstituted hydrocarbon group bonded directly to a carbon atom of the pyrimidine ring or through an O— or S— atom thereto, a heterocyclic-substituted alkyl radical,
- a nitro group,
- an azophenyl group,
- an alkylsulphonyl group,

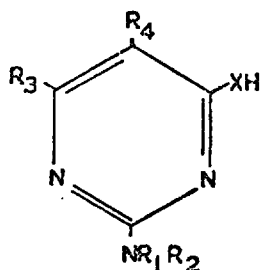
or R₃ and R₄ together form a substituted or unsubstituted alkylene or alkenylene bridging group; and wherein X is an atom of oxygen or sulphur; and a carrier for the active ingredient comprising a solid diluent, or a liquid diluent containing a surface active agent.

A preferred fungicidal composition according to the invention comprises as an active ingredient an acid addition salt or metal salt of a pyrimidine derivative of the formula:—



or an acid addition salt of an ether thereof, wherein R_1 is hydrogen, alkyl, or substituted or unsubstituted aralkyl; R_2 is hydrogen, alkyl, alkenyl, unsubstituted aryl or halo-, alkyl-, or alkoxy-carbonyl-substituted aryl, unsubstituted or sulphur-free substituted amino, cyano, alkylcarbonyl, haloalkylcarbonyl, heterocyclic, heterocyclic-substituted alkyl, carbamoyl, or R_1 and R_2 together with the adjacent N-atom form a heterocyclic ring which may contain one or more additional heterocyclic atoms; R_3 and R_4 are hydrogen, halogen, alkyl, alkaryl, alkenyl, alkylthioalkyl, alkoxyalkyl, hydroxyhaloalkyl, nitro, heterocyclic substituted alkyl which may contain an N-atom, unsubstituted or substituted aryl or aryloxy, or arylthio, azophenyl, alkylamino, or alkylsulphonyl; and X is an atom of oxygen or sulphur; and a carrier for the active ingredient comprising a solid diluent, or a liquid diluent containing a surface active agent.

A particularly preferred composition according to the invention comprises as an active ingredient an acid addition salt or a metal salt of a pyrimidine derivative of the formula:—



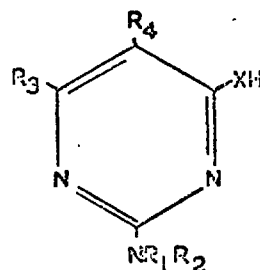
or an acid addition salt of an ether thereof, wherein R_1 and R_2 are hydrogen or lower alkyl groups, or R_1 and R_2 together with the adjacent nitrogen atom form a heterocyclic ring; R_3 is a lower alkyl group; R_4 is a lower alkyl or alkenyl group; and X is an atom of oxygen or sulphur; and a carrier for the active ingredient comprising a solid diluent, or a liquid diluent containing a surface active agent.

By the terms "lower alkyl" and "lower alkenyl" are intended groups containing from 1 to 8 carbon atoms.

More especially the invention provides a fungicidal composition according to the foregoing paragraph wherein the active ingredient is an acid addition salt or a metal salt of a compound in which R_1 , R_2 and R_3 are methyl or ethyl groups; R_4 is an alkyl or alkenyl group containing from one to five carbon atoms; and X is an atom of oxygen or sulphur.

The invention also includes a fungicidal composition wherein the active ingredient is a salt of a pyrimidine derivative as defined above and in which the group —XH is etherified having an ether group comprising an alkyl, hydroxyalkyl, aralkyl, alkenyl, alkoxy-carbonylalkyl, alkylcarbonylalkyl, alkyl-aminoalkyl or alkylthioalkyl residue.

According to a further feature of the invention we provide acid addition salts and metal salts of a pyrimidine derivative of the formula:—



or acid addition salts of an ether thereof, wherein R_1 and R_2 are:

hydrogen,
alkyl, alkenyl, haloaryl, alkaryl, alkoxy-carbonylaryl,
a substituted or unsubstituted aralkyl,
unsubstituted aryl,
a heterocyclic ring,
a benzylidene-imino group,
an amino or sulphur-free substituted amino group,
a cyano group,
a substituted or unsubstituted carbamoyl group,
an $R \cdot CO-$ or $R \cdot SO_2-$ group where R is a substituted or unsubstituted hydrocarbon group,

or R_1 and R_2 , together with the adjacent N-atom, form a substituted or unsubstituted heterocyclic ring which may contain one or more additional heterocyclic atoms;

and wherein R_3 and R_4 are:

hydrogen,
a substituted or unsubstituted hydrocarbon group bonded directly to a carbon atom of the pyrimidine ring or through an O— or S— atom thereto,
a heterocyclic-substituted alkyl radical,
a nitro group,

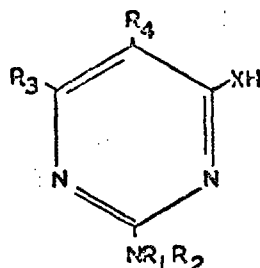
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wherein X
provided
5 is hydrog
and R_2 is
 R_2 are no
are both
Preferre
10 are acid
pyrimidine

and acid
wherein R
or unsubsti
alkenyl, un
alkoxy-carb
or sulphur
alkylcarbonyl
heterocyclic
20 R_1 and R_2
atom form
tain one or
 R_3 and R_4
25 alkylthioalk
nitro, heter
contain an
tuted aryl
alkylamino
30 of oxygen
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and R_3 are
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40 and acid ac
wherein R_1

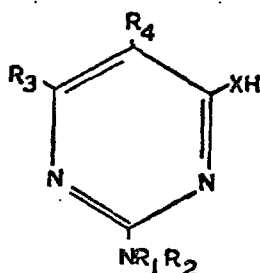
an azophenyl group
 an alkylsulphonyl group;
 wherein X is an atom of oxygen or sulphur;
 provided that R_1 is not hydrogen when R_3
 5 is hydrogen, or when R_1 and R_3 are alkyl
 and R_2 is hydrogen or alkyl, and that R_1 and
 R_2 are not both hydrogen when R_3 and R_4
 are both alkyl groups.

10 Preferred salts according to the invention
 are acid addition salts and metal salts of a
 pyrimidine derivative of the formula:—



15 and acid addition salts of an ether thereof,
 wherein R_1 is hydrogen, alkyl, or substituted
 or unsubstituted aralkyl; R_2 is hydrogen alkyl,
 alkenyl, unsubstituted aryl or halo-, alkyl-, or
 alkoxy-carbonyl-substituted aryl, unsubstituted
 or sulphur-free substituted amino, cyano,
 20 alkylcarbonyl, haloalkylcarbonyl, heterocyclic,
 heterocyclic-substituted alkyl, carbamoyl, or
 R_1 and R_2 together with the adjacent N-
 atom form a heterocyclic ring which may con-
 tain one or more additional heterocyclic atoms;
 R_3 and R_4 are hydrogen, alkyl, aralkyl, alkenyl,
 25 alkylthioalkyl, alkoxyalkyl, hydroxyhaloalkyl,
 nitro, heterocyclic substituted alkyl which may
 contain an N-atom, unsubstituted or substi-
 tuted aryl or aryloxy or arylthio, azophenyl,
 alkylamino or alkylsulphonyl; X is an atom
 30 of oxygen or sulphur; provided that R_1 is
 not hydrogen when R_3 is hydrogen, or when R_1
 and R_3 are alkyl and R_2 is hydrogen or alkyl,
 and that R_1 and R_2 are not both hydrogen
 when R_3 and R_4 are both alkyl groups.

35 Particularly preferred salts according to the
 invention are acid addition salts and metal
 salts of a pyrimidine derivative of the for-
 mula:—



40 and acid addition salts of an ether thereof,
 wherein R_1 and R_2 are hydrogen or lower

alkyl groups, or R_1 and R_2 together with
 the adjacent nitrogen atom form a hetero-
 cyclic ring; R_3 is a lower alkyl group; R_4
 45 is a lower alkyl or alkenyl group; X is an
 atom of oxygen or sulphur; provided that R_1
 is not hydrogen when R_3 , R_2 and R_4 are all
 alkyl groups and that R_1 and R_2 are not both
 hydrogen when R_3 and R_4 are both alkyl
 groups.

Especially preferred acid addition and metal
 salts according to the invention are those of a
 pyrimidine derivative having the formula set
 out in the preceding paragraph and wherein
 R_1 , R_2 and R_3 are methyl or ethyl groups; R_4
 55 is an alkyl or alkenyl group containing from
 2 to 5 carbon atoms; and X is an atom of
 oxygen or sulphur.

The invention also includes acid addition
 salts of pyrimidine derivatives having the
 above general formula and in which the groups
 R_1 , R_2 , R_3 and R_4 are as defined above and
 wherein the group —XH is etherified having
 an ether group comprising an alkyl, hydroxy-
 alkyl, aralkyl, alkenyl, alkoxy-carbonylalkyl,
 65 alkylcarbonylalkyl, alkylaminoalkyl, or alkyl-
 thioalkyl residuc.

The salts of the pyrimidine derivatives are
 metal salts or acid addition salts. Suitable
 metal salts include alkali metal salts, for
 example the sodium and potassium salts, or
 salts of noble metals, for example, silver salts.
 Other suitable metal salts include the di-
 mercury and mercuri-chloride salts. Suitable
 acid salts include salts formed from organic
 or inorganic acids. Organic acids which may be
 used include:—

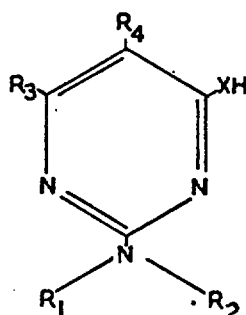
para-toluenesulphonic acid,
 2,4,6-trinitrobenzenesulphonic acid,
 3,5-dinitrobenzoic acid,
 80 trichloroacetic acid,
 oxalic acid,
 citric acid,
 picric acid.

Inorganic acids which may be used in-
 clude:—

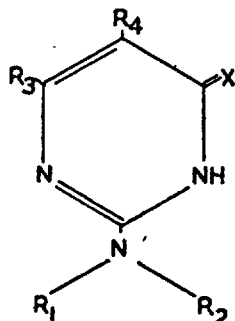
hydrochloric acid,
 hydrobromic acid,
 nitric acid,
 sulphuric acid,
 90 phosphoric acid,
 fluoroboric acid,
 thiocyanic acid,
 perchloric acid.

A preferred salt is an alkali metal salt or
 a hydrohalide, especially the latter. A salt
 which is a hydrochloride of a pyrimidine deri-
 vative is particularly preferred.

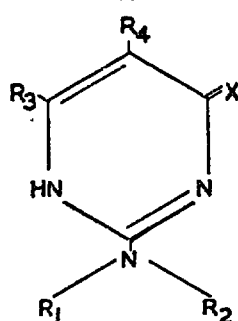
The pyrimidine derivative from which suit-
 able salts may be obtained are, for conveni-
 100 ence, referred to throughout the present speci-
 fication and claims as having the formula:—



where X is sulphur or oxygen. The compounds, however, also exist with tautomeric structures of the following form:—



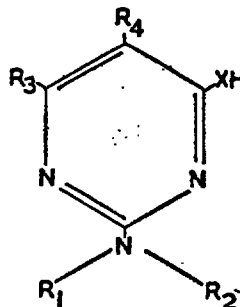
or



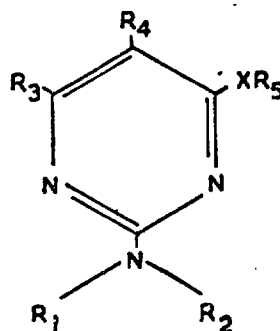
and the present invention is to be understood as including salts of the tautomeric forms of such compounds.

Specific pyrimidine derivatives particularly useful for forming the salts are listed in Tables I to III below. In Table I are listed hydroxypyrimidines and in Tables II and III there are set out various O— and S— etheri-

fied pyrimidine derivatives. The groups NR₁, R₂, R₃ and R₄ in Table I, and additionally the group XR₅ in Tables II and III correspond to Formulas I and II below. In all three of these Tables melting points (m.p.) and boiling points (b.p.) are expressed in degrees Centigrade.

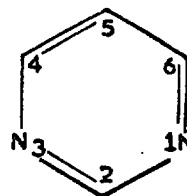


FORMULA I
(Table I)



FORMULA II
(Table II)

In this specification the numbering of the pyrimidine ring is as follows:—



It may be noted that the 4- and 6- positions are equivalent.

TABLE I

Hydroxypyrimidines
(wherein X in the formula I above is oxygen)

TABLE I

Hydroxypyrimidines
(wherein X in the formula I above is oxygen)

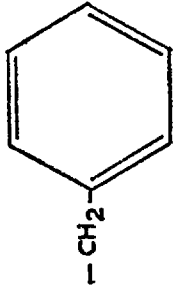
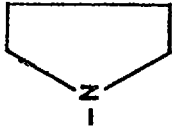
Compound No.	NR ₁ R ₂	R ₃	R ₁	Physical Characteristics
1	—NH.CN	CH ₃	nC ₄ H ₉	m.p. 295—298°
2	—N(CH ₃) ₂	CH ₃	nC ₅ H ₁₁	m.p. 84°
3	—N(CH ₃) ₂	CH ₃	nC ₃ H ₇	m.p. 120°
4	—N(CH ₃) ₂	CH ₃	nC ₄ H ₉	m.p. 102°
5	—N(CH ₃) ₂	CH ₃	nC ₆ H ₁₃	m.p. 80°
6	—NH ₂	CH ₃	nC ₄ H ₉	m.p. 257°
7	—N(CH ₃) ₂	CH ₃	Br	m.p. 232—233°
8	—NH ₂	CH ₃		m.p. 277.5—278.5°
9		CH ₃	nC ₄ H ₉	m.p. 149°

TABLE I (Continued)

Hydroxypyrimidines
(wherein X in the formula I above is oxygen)

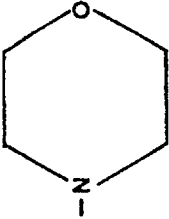
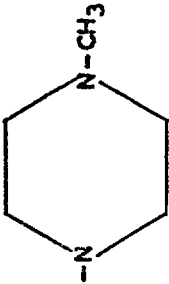
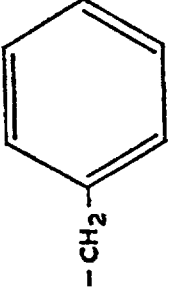
Compound No.	NR ₁ R ₂	R ₃	R ₄	Physical Characteristics
10		CH ₃	nC ₄ H ₉	m.p. 192—195°
11	—N(CH ₃) ₂	C ₂ H ₅	H	m.p. 140°
12	—N(CH ₃) ₂	CH ₃	$\begin{array}{c} \text{—CH}_2 \\ \\ \text{CH=CH}_2 \end{array}$	m.p. 174°
13	—NH—C ₆ H ₄ ·Br(p)	CH ₃	nC ₄ H ₉	m.p. 176°
14	—NH—C ₆ H ₄ —CO·OC ₂ H ₅ (p)	CH ₃	nC ₄ H ₉	m.p. 147—150°
15	—NH—C ₆ H ₄ —CH ₃ (p)	CH ₃	nC ₄ H ₉	m.p. 185—187°
16		CH ₃	nC ₄ H ₉	m.p. 162—164°
17	—N(CH ₃) ₂	CH ₃		m.p. 188—190°

TABLE I (Continued)

Compound No.	Physical
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TABLE I (Continued)

Compound No.	NR_1R_2	R_3	R_4	Physical Characteristics
18	$-\text{N}(\text{CH}_3)_2$		$n\text{C}_4\text{H}_9$	m.p. 182°
19	$-\text{N}(\text{CH}_3)_2$	CH_3	$-\text{CH}(\text{CH}_3)_2$	m.p. $181-183^\circ$
20	$-\text{NH}-(\text{CH}_2)_3-\text{N}$ 	CH_3	$n\text{C}_4\text{H}_9$	m.p. $139-141^\circ$
21	$-\text{N}-\text{CH}_2-$ 	CH_3	$n\text{C}_4\text{H}_9$	m.p. 151°
22	$-\text{NH}-\text{CO}-\text{NH}_2$	CH_3	$n\text{C}_4\text{H}_9$	m.p. 207°
23	$-\text{NH}-\text{NH}-$ 	CH_3	$n\text{C}_4\text{H}_9$	m.p. 185°

TABLE I (Continued)

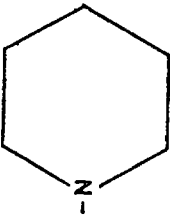
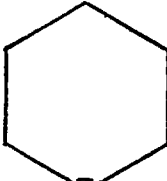
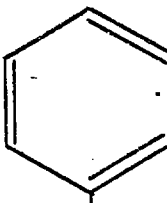
Compound No.	NR ₁ R ₂	R ₃	R ₄	Physical Characteristics
24		CH ₃		m.p.
25	-N(C ₄ H ₉) ₂	CH ₃	nC ₄ H ₉	m.p. 145—148°
26	-NH-NH ₂	CH ₃	nC ₄ H ₉	m.p. 201—212°
27	-NH-CO-CH ₃	CH ₃	nC ₄ H ₉	m.p. 153°
28	-NH-CH(CH ₃) ₂	CH ₃	nC ₄ H ₉	m.p. 135—137°
29	 -NH-CH ₂ -	CH ₃	nC ₄ H ₉	m.p. 76°
30	-NHC ₂ H ₅	CH ₃	nC ₄ H ₉	m.p. 159°
31	-N(CH ₃) ₂	CH ₃ -CH ₂ -SCH ₂	H	m.p. 118°
32	-N(CH ₃) ₂	CH ₃	CH ₃ ·CH ₂ ·OCH ₂ ·CH ₂ -	m.p. 104—105°
33	-N(CH ₃) ₂	H	nC ₄ H ₉	m.p. 84°
34	-NHnC ₄ H ₉	CH ₃	nC ₄ H ₉	m.p. 143°
35	-N(CH ₃) ₂	CH ₃	CH ₃ -SO ₂ -	m.p. 235°
37	-NH ₂	CH ₃	CH ₃ CH=CH ₂	m.p. 266—267°

TABLE I (Continued)

Compound No.	NR ₁ R ₂	R ₃	R ₄	Physical Characteristics
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TABLE I (Continued)

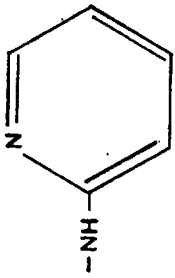
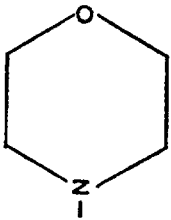
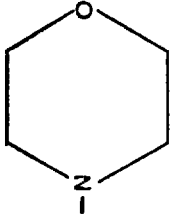
Compound No.	NR ₁ R ₂	R ₃	R ₄	Physical Characteristics
38	—N(CH ₃) ₂	CH ₃	CH(OH)CCl ₃	m.p. 221—222° (with decomposition)
39	—N(CH ₃) ₂	H	CH(OH)CCl ₃	m.p. 228—229° (with decomposition)
40	—NH—CH ₃	CH ₃	CH(OH)CCl ₃	m.p. 196°
41		CH ₃	H	m.p. 205—207°
42	—NH—CH ₂ .CH=CH ₂	CH ₃	nC ₄ H ₉	m.p. 165—167°
43	—N(CH ₃) ₂	H	NO ₂	m.p. 301°
44		CH ₃	CH ₃	m.p. 201°
45		nC ₃ H ₇	H	m.p. 174—175°

TABLE I (Continued)

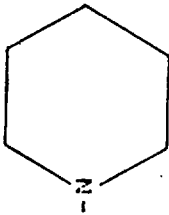
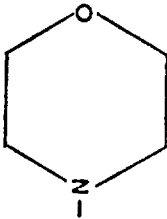
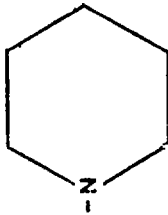
Compound No.	NR ₁ R ₂	R ₃	R ₄	Physical Characteristics
46		CH ₃	CH ₃	m.p. 157°
47	—N(CH ₃) ₂	CH ₃	C ₂ H ₅	m.p. 141°
48	—N(CH ₃) ₂	H	H	m.p. 175—176°
49	—NH ₂	CH ₃	nC ₃ H ₁₁	m.p. 234°
50	—NH ₂	CH ₃	nC ₈ H ₁₃	m.p. 236°
51	—NH ₂	CH ₃	CH ₃	m.p. 304—306°
52	—N(CH ₃) ₂	nC ₃ H ₇	H	m.p. 127°
53		CH ₃	nC ₃ H ₇	m.p. 238°
54		CH ₃	nC ₄ H ₉	m.p. 126°

TABLE I (Continued)

Compound No.	NR ₁ R ₂	R ₃	R ₄	Physical Characteristics
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TABLE I (Continued)

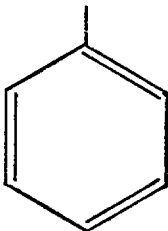
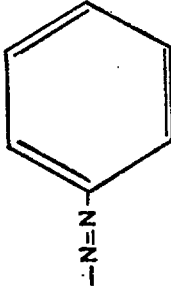
Compound No.	NR ₁ R ₂	R ₃	R ₄	Physical Characteristics
55	—N(CH ₃) ₂		H	m.p. 243°
56	—N(CH ₃) ₂			m.p. 224—225°
57	—N(CH ₃) ₂	CH ₃		m.p. 147—150°
58	—N(CH ₃) ₂	CH ₃	nC ₈ H ₁₇	m.p. 57°
59	—N(CH ₃) ₂	nC ₆ H ₁₃	H	m.p. 80—81°
60	—NH—NH ₂	CH ₃	nC ₃ H ₇	m.p. 216—218°
61	—NH.C ₃ H ₇	CH ₃	nC ₄ H ₉	m.p. 154°
62	—N(CH ₃) ₂	CH ₃	iso C ₄ H ₉	m.p. 150°
63	—N(CH ₃) ₂	H	CH ₂ =CH—CH ₂	m.p. 94°
64	—N(CH ₃) ₂	CH ₃	(CH ₂) ₂ .CH.CH ₂ .CH ₂	m.p. 151°
65	—NH.CO.CF ₃	CH ₃	nC ₄ H ₉	m.p. 128—129°
66	—N(CH ₃) ₂	nC ₃ H ₇	C ₂ H ₅	m.p. 103—104°

TABLE I (Continued)

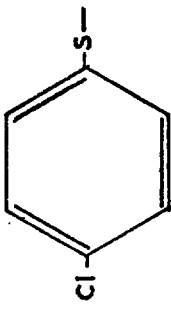
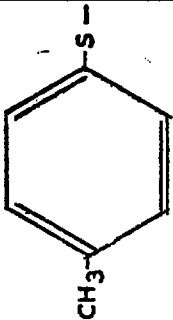
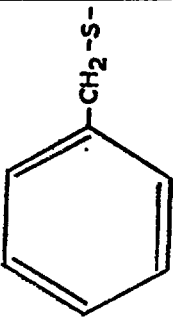
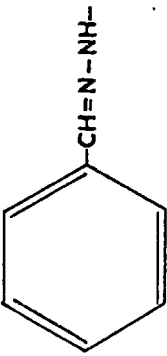
Compound No.	NR ₁ R ₂	R ₃	R ₄	Physical Characteristics
67	$-\text{N}(\text{CH}_3)_2$	CH_3		m.p. 210°
68	$-\text{NH COCH}_2\text{Cl}$	CH_3	$n\text{C}_4\text{H}_9$	m.p. 156°
69	$-\text{N}(\text{CH}_3)_2$	C_2H_5	$n\text{C}_4\text{H}_9$	m.p. 100°
70	$-\text{N}(\text{CH}_3)_2$	CH_3		m.p. 220°
71	$-\text{N}(\text{CH}_3)_2$	CH_3		m.p. 175—176°
72	$\begin{array}{c} \text{NH} \\ \parallel \\ \text{NH}_2\text{C}-\text{NH}- \end{array}$	CH_3	$n\text{C}_3\text{H}_7$	m.p. 291—293°
73		CH_3	$n\text{C}_3\text{H}_7$	m.p. 199°

TABLE I (Continued)

Compound No.	NR ₁ R ₂	R ₃	R ₄	Physical Characteristics
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TABLE I (Continued)

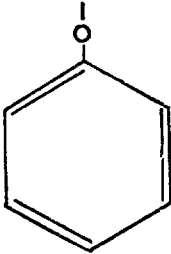
Compound No.	NR_1R_2	R_3	R_4	Physical Characteristics
74	$\begin{array}{c} \text{CH}_3 \\ \diagup \\ -\text{N} \\ \diagdown \\ \text{C}_2\text{H}_5 \end{array}$	CH_3	$n\text{C}_4\text{H}_9$	m.p. 101°
75	$\begin{array}{c} \text{CH}_3 \\ \diagup \\ -\text{N} \\ \diagdown \\ \text{C}_2\text{H}_5 \end{array}$	CH_3	$n\text{C}_3\text{H}_7$	m.p. $116-117^\circ$
76	$\begin{array}{c} \text{NO}_2 \\ \\ \text{C}_6\text{H}_4 \\ \\ -\text{N}(\text{C}_2\text{H}_5)_2 \end{array}$	CH_3	$n\text{C}_3\text{H}_7$	m.p. $114-115^\circ$
77	$\begin{array}{c} \text{NO}_2 \\ \\ \text{C}_6\text{H}_4 \\ \\ -\text{NH}\cdot\text{SO}_2- \end{array}$	CH_3	$\text{CH}_2=\text{CH}-\text{CH}_2-$	m.p. $233-234^\circ$
78	$-\text{NH}\cdot\text{CO}\cdot\text{CH}_3$	H		m.p. $230-321^\circ$

TABLE I (Continued)

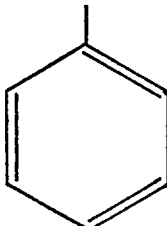
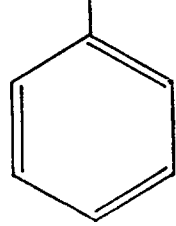
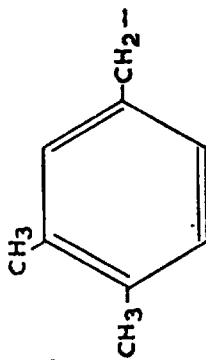
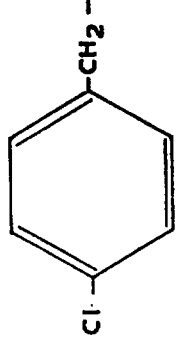
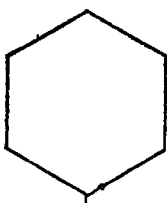
Compound No.	NR ₁ R ₂	R ₃	R ₄	Physical Characteristics
79	-NH ₂	H		m.p. 268-270°
80	-NH.CO.CH ₃	H		m.p. 307°
81	-N(CH ₃) ₂	CH ₃		m.p. 182°
82	-N(CH ₃) ₂	CH ₃		m.p. 220°
83		CH ₃	nC ₃ H ₇	m.p. 220°

TABLE I (Continued)

Compound No.	NR ₁ R ₂	R ₃	R ₄	Physical Characteristics
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TABLE I (Continued)

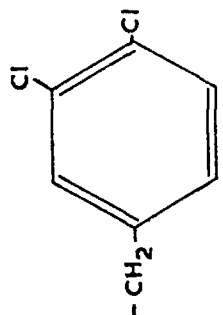
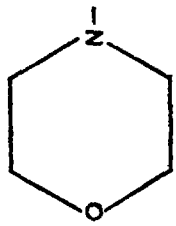
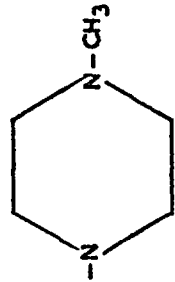
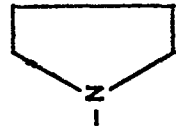
Compound No.	NR ₁ R ₂	R ₃	R ₄	Physical Characteristics
84	—N(CH ₃) ₂	CH ₃		m.p. 140°
85		H	CH(OH)CCl ₃	m.p. 202.203°
86		H	CH(OH)CCl ₃	m.p. 205°
87		CH ₃	CH(OH)CCl ₃	m.p. 213°
88	—NHC ₂ H ₅	H	CH(OH)CCl ₃	m.p. 188—190°C
89	—N(C ₂ H ₅) ₂	CH ₃	C ₂ H ₅	m.p. 121—122°
90	—N(C ₂ H ₅) ₂	CH ₃	—CH ₂ —CH=CH ₂	m.p. 110—111°
91	—N(CH ₃) ₂	H	C ₂ H ₅	m.p. 124—125°

TABLE I (Continued)

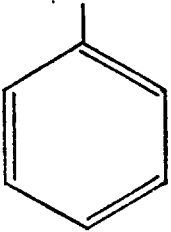
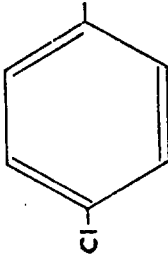
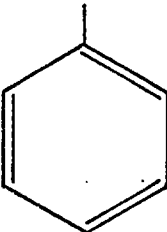
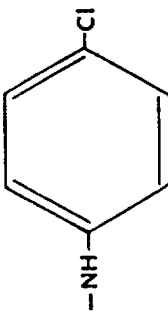
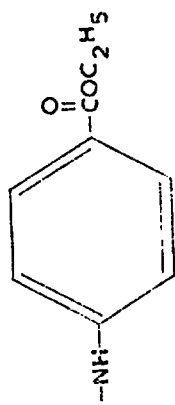
Compound No.	NR ₁ R ₂	R ₃	R ₄	Physical Characteristics
92	$-\text{N}(\text{CH}_3)_2$		$\text{CH}_2=\text{CH}\cdot\text{CH}_2-$	m.p. 196°
93	$-\text{N}(\text{CH}_3)_2$		H	m.p. 260—261°
94	$-\text{N}(\text{CH}_3)_2$		C_2H_5	m.p. 175°
95		CH_3	$n\text{C}_3\text{H}_7$	m.p. 217—219°
96		CH_3	$n\text{C}_3\text{H}_7$	m.p. 216—218°

TABLE I (Continued)

Compound

TABLE I (Continued)

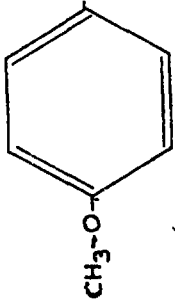
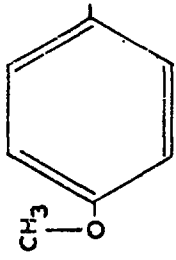
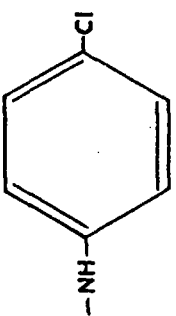
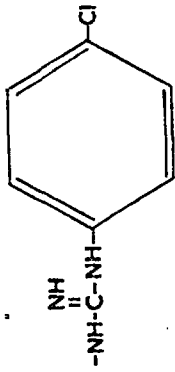
Compound No.	NR ₁ R ₂	R ₃	R ₄	Physical Characteristics
97	$-\text{N}(\text{CH}_3)_2$		H	m.p. 280—281°
98	$-\text{NHC}_2\text{H}_5$		H	m.p. 199°
99	$-\text{NH}_2$	CH ₃	C ₂ H ₅	m.p. 288—289°
100	$-\text{NH}_2$	Cl	H	m.p. 261°
101		CH ₃	Br	m.p. 267.269°
102		CH ₃	CH ₃	

TABLE I (Continued)

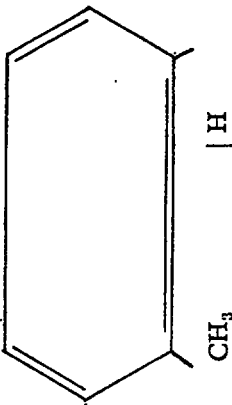
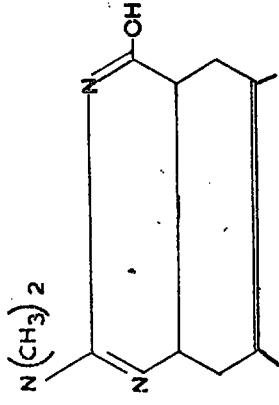
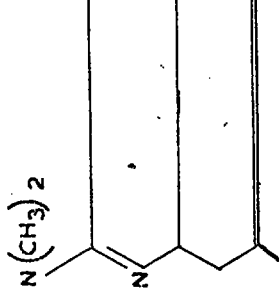
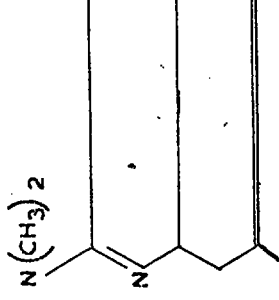
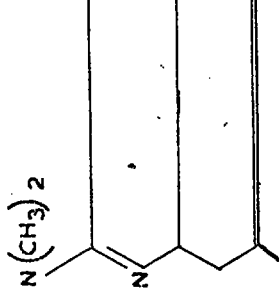
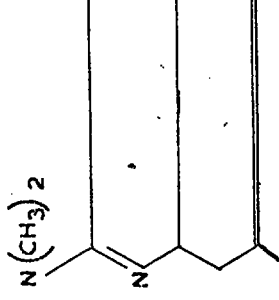
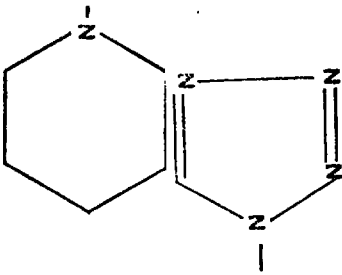
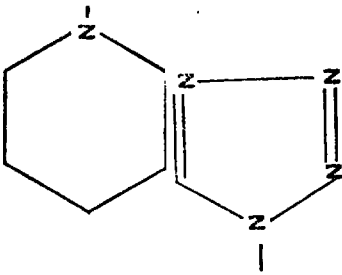
Compound No.	NR ₁ R ₂	R ₃	R ₄	Physical Characteristics
103	$-\text{NH}-\text{CH}-(\text{CH}_3)_2$			m.p. 212—213°
104	$-\text{N}(\text{CH}_3)_2$			m.p. 175—176°
105	$-\text{N}(\text{CH}_3)_2$			m.p. above 340°
106		CH ₃	CHO	m.p. 235°
107		CH ₃	H	m.p. 220—222°

TABLE II
ETHERIFIED HYDROXYPYRIMIDINES (of the general Formula II)
(wherein X = 0)

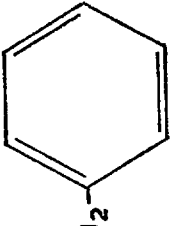
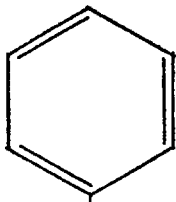
Compound No.	NR ₁ R ₂	R ₃	R ₄	XR ₅	Physical Characteristics
108	—N(CH ₃) ₂	CH ₃	nC ₄ H ₉	O—CH ₂ —CH ₂ —OH	b.p. 126—128°/0.4 mm.
109	—N(CH ₃) ₂	CH ₃	nC ₄ H ₉	O·CH ₂ —CH ₂ —N(C ₂ H ₅) ₂	b.p. 126—128°/0.23 mm.
110	—N(CH ₃) ₂	H	H	 —O·CH ₂	b.p. 118—120°/0.1 mm.
111	—N(CH ₃) ₂	H	H	O·CH ₂ ·CH=CH ₂	b.p. 60—65°/0.1 mm.
112	—N(CH ₃) ₂	CH ₃	CH ₃	O·CH ₂ ·OH ₂ OH	m.p. 79—80°

TABLE III
SULPHUR-CONTAINING PYRIMIDINES (of the General Formula II)
(wherein X = S)

Compound No.	NR ₁ R ₂	R ₃	R ₁	XR ₅	Physical Characteristics
113	-N(CH ₃) ₂	CH ₃	nC ₄ H ₉	-SH	m.p. 105-106°
114	-N(CH ₃) ₂	CH ₃	nC ₄ H ₉	-S-CH ₂ -C(=O)-CH ₃	m.p. 48°
115	-N(CH ₃) ₂	CH ₃	C ₂ H ₅	-SH	m.p. 140-141°
116	-N(CH ₃) ₂	CH ₃	nC ₄ H ₉	-S-CH ₂ -CH ₂ -N(CH ₃) ₂	b.p. 153°/0.23 mm. n _D ²⁵ 1.5452
117	-N(CH ₃) ₂	CH ₃	nC ₄ H ₉	-S-CH ₂ -CH ₂ -S-C ₂ H ₅	b.p. 160°/0.33 mm. n _D ²⁵ 1.5670
118	-N(CH ₃) ₂	CH ₃	nC ₄ H ₉	-S-CH ₂ - 	m.p. 52-53°
120	-N(CH ₃) ₂	CH ₃	CH ₃	-SH	m.p. 162-163°
121	-N(CH ₃) ₂	CH ₃	nC ₄ H ₉	-S-CH ₂ -CH ₂ -OC ₂ H ₅	b.p. 146°/0.5 mm.
122	-N(CH ₃) ₂	CH ₃	H	-SH	m.p. 154-155°
123	-N(CH ₃) ₂	H	H	-SH	m.p. 149°
124	-N(CH ₃) ₂	CH ₃	nC ₄ H ₉	-S-CH ₂ -C(=O)-C ₂ H ₅	m.p. 64°
125	-N(CH ₃) ₂	CH ₃	nC ₄ H ₉	-S-CH ₂ -CH ₂ -N(C ₂ H ₅) ₂	b.p. 150°/0.22 mm. n _D ²⁵ 1.5411

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We have found that the fungicidal properties of the salts of the pyrimidine derivatives are decreased if in the above derivatives on which the salts are based both R_1 and R_2 are hydrogen, or if R_1 is an alkyl radical containing more than 7 carbon atoms.

A particularly useful pyrimidine derivative for preparing a salt is that in which R_1 and R_2 are both methyl, R_3 is methyl, R_4 is nC_4H_9 , and XR_5 is OH, that is compound No. 4 in the foregoing Table I. Other particularly useful salts of pyrimidine derivatives are those based on the following compound numbers in the foregoing tables:—2, 3, 9, 12, 28, 30, 37, 61, 69, 74, 90, 115, 116 and 125. According to a preferred embodiment of the invention, we provide a salt of the following pyrimidine derivatives:—

2 - dimethylamino - 4 - methyl - 5 - n-butyl - 6 - hydroxypyrimidine and
2 - ethylamino - 4 - methyl - 5 - n-butyl - 6 - hydroxypyrimidine,
particularly the hydrohalides, and especially the hydrochlorides thereof.

The salts of the pyrimidine derivatives possess fungicidal activity against a wide variety of fungal diseases including the following specific diseases:—

Puccinia recondita (brown rust) on wheat
30 *Phytophthora infestans* (late blight) on tomatoes
Sphaerotheca fuliginea (powdery mildew) on cucumber
Erysiphe graminis (powdery mildew) on wheat and barley
35 *Podosphaera leucotricha* (powdery mildew) on apple
Uncinula necator (powdery mildew) on vine
Plasmopara viticola (downy mildew) on vine
40 *Piricularia oryzae* (blast) on rice
Venturiria inaequalis (scab) on apple
Pythium ultimum on peas
Fusarium culmorum on wheat

Satisfactory results are generally obtained using a formulation containing 500 ppm. of the fungicidally active salt, and in many cases useful results may be obtained using even lower concentrations.

A particularly useful feature of the activity of the salts of the pyrimidine derivatives listed above is their systemic effect, that is to say, their ability to move throughout the plant to reach any part thereof bearing a fungal infection and to combat the infection.

The fungicidal compositions and salts of the invention can be used to combat plant pathogens in a number of ways. Thus they can be applied to the foliage of an infected plant, to seed or to the soil in which plants are growing or to be planted.

In a further aspect the invention includes a method for the combating of undesired fungal infections in growing plants which comprises applying to the locus of the plant a

fungicidal composition or a salt as hereinbefore defined. 65

The invention includes therefore a method of combating plant pathogens in which a plant susceptible to such pathogens, or seed thereof, is treated with a fungicidal composition or a salt, as hereinbefore defined. 70

The compositions or salts may be used for agricultural and horticultural purposes and the type of composition of salt used in any instance will depend upon the particular purpose for which it is to be used. 75

In choosing any particular composition or salt for use in treating plants, either by application to the soil or directly onto the plant, a factor which should be taken into account is the relative phytotoxicity of the particular acid from which the salt is derived but this problem is minimized by the fact that normally only very small amounts of the salts of the pyrimidine derivatives need to be used to achieve a fungicidal effect and undesired phytotoxic effects can therefore be, in general, avoided by reducing the amount of active ingredient used. 80

The compositions may be in the form of dusting powders or granules wherein the active ingredient is mixed with a solid diluent or carrier. Suitable solid diluents or carriers may be, for example, kaolin, bentonite, kieselsguhr, dolomite, calcium carbonate, talc, powdered magnesia, Fuller's earth, gypsum, Hewitt's earth, diatomaceous earth and China clay. Compositions for dressing seed, for example, may comprise an agent assisting the adhesion of the composition to the seed, for example a mineral oil. 85

The compositions may also be in the form of dispersible powders or grains comprising, in addition to the active ingredient, a surface active agent to facilitate the dispersion of the powder or grains in liquids. Such powders or grains may include fillers and suspending agents. 90

The compositions may also be, and preferably are, in the form of liquid preparations to be used as soil drenches, sprays or dips which are generally aqueous solutions, dispersions, or emulsions containing the active ingredient, if required in the presence of one or more surface active agents such as, for example, wetting agents, dispersing agents, emulsifying agents, suspending agents or corrosion inhibitors (e.g. lauryl isoquinolinium bromide). Water or organic liquids may be used to prepare solutions, dispersions or emulsions of the active ingredient and aqueous solutions of the salts of the invention are particularly preferred compositions. 105

Wetting agents, dispersing agents and emulsifying agents, if used, may be of the cationic, anionic or non-ionic type. Suitable agents of the cationic type include, for example, quaternary ammonium compounds, for 125

b.p. 150°/0.22 mm
nd_D²⁰ 1.5411

—S·CH₂·CH₂·CH₂·N(C₂H₅)₂

nC₄H₉

CH₃

—N(CH₃)₂

125

example, cetyltrimethylammonium bromide. Suitable agents of the anionic type include, for example, soaps, salts of aliphatic monoesters of sulphuric acid, for example sodium lauryl sulphate, salts of sulphonated aromatic compounds, for example sodium dodecylbenzenesulphonate sodium, calcium or ammonium lignosulphonate, butyl-naphthalene sulphonate, and a mixture of the sodium salts of diisopropyl- and triisopropyl-naphthalene sulphonic acids. Suitable agents of the non-ionic type include, for example, the condensation products of ethylene oxide with fatty alcohols such as oleyl alcohol or cetyl alcohol, or with alkyl phenols such as octylphenol, nonylphenol and octylcresol. Other non-ionic agents are the partial esters derived from long chain fatty acids and hexitol anhydrides, the condensation products of the said partial esters with ethylene oxide, and the lecithins. Suitable suspending agents are, for example, hydrophilic colloids, for example polyvinylpyrrolidone and sodium carboxymethylcellulose, and the vegetable gums, for example gum acacia and gum tragacanth.

The aqueous solutions, dispersions or emulsions may be prepared by dissolving the active ingredient or ingredients in water or an organic solvent which may, if required, contain one or more surface active agents such as, for example, wetting, dispersing, or emulsifying agents and then, in the case when organic solvents are used, adding the mixture so obtained to water which may, if required, likewise contain one or more wetting, dispersing or emulsifying agents. Suitable organic solvents are ethylene dichloride, isopropyl alcohol, propylene glycol, diacetone alcohol, toluene, kerosene, methylnaphthalene, xylenes and trichloroethylene.

The compositions to be used as sprays may also be in the form of aerosols wherein the formulation is held in a container under pressure in the presence of a propellant such as fluorotrichloromethane or dichlorodifluoromethane.

By the inclusion of suitable additives, for example for improving the distribution, adhesive power and resistance to rain on treated surfaces, the different compositions can be better adapted for the various uses for which they are intended.

The salts of the pyrimidine derivatives may also be conveniently formulated by admixing them with fertilisers. A preferred composition of this type comprises granules of fertiliser material incorporating, for example coated with, a salt of a pyrimidine derivative. The fertiliser material may, for example, comprise nitrogen or phosphate-containing substances.

The compositions which are to be used in the form of aqueous solutions, dispersions or emulsions are generally supplied in the form of a concentrate containing a high proportion of the active ingredient or ingredients, and the

concentrate is diluted with water before use. These concentrates are often required to withstand storage for prolonged periods and after such storage, to be capable of dilution with water in order to form aqueous preparations which remain homogeneous for a sufficient time to enable them to be applied by conventional spray equipment. The concentrates may conveniently contain from 10—85% by weight of the active ingredient or ingredients and generally from 25—60% by weight of the active ingredient or ingredients. When diluted to form aqueous preparations, such preparations may contain varying amounts of the active ingredient or ingredients depending upon the purpose for which they are to be used, but an aqueous preparation containing between 0.001% and 10.0% by weight of active ingredient or ingredients may be used.

It is to be understood that the fungicidal compositions of this invention may comprise, in addition to a salt of a pyrimidine derivative, one or more other compounds having biological activity.

Various methods well-known to those skilled in the art may be used to prepare the fungicidally-active salts of the pyrimidine derivatives and in so far as these methods are pertinent to the preparation of the salts they form part of the present invention. For example the corresponding sodium salt can be prepared by treating a pyrimidine derivative with sodium hydroxide and acid salts by treatment with the corresponding acid. Further methods are outlined in the following examples which illustrate the invention.

EXAMPLE 1.

This Example illustrates the preparation of the hydrochloride of 2 - dimethylamino - 4 - methyl - 5 - *n* - butyl - 6 - hydroxypyrimidine (Compound No. 4 of Table I). 2 - Dimethylamino - 4 - methyl - 5 - *n* - butyl - 6 - hydroxypyrimidine (10 g.) was mixed thoroughly with concentrated hydrochloric acid of specific gravity 1.18. There was thereby obtained a powder comprising 2 - dimethylamino - 4 - methyl - 5 - *n* - butyl - 6 - hydroxypyrimidine hydrochloride (11.7 g.). This was recrystallised using isopropyl alcohol/benzene and gave a melting point of 167°C.

In exactly the same manner the hydrochloride of 2 - ethylamino - 4 - methyl - 5 - *n* - butyl - 6 - hydroxypyrimidine (Compound No. 30 of Table I) was prepared.

EXAMPLE 2.

This Example illustrates the preparation of an aqueous solution of the hydrochloride of 2 - dimethylamino - 4 - methyl - 5 - *n* - butyl - 6 - hydroxypyrimidine (Compound No. 4 of Table I). 2 - Dimethylamino - 4 - methyl - 5 - *n* - butyl - 6 - hydroxypyrimidine (10 g.) were added to water (10 ml.) and concentrated hydrochloric acid was added (3.8 g.). The

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resultant mixture was then warmed to 50°C. and held at this temperature until a clear solution was obtained. After cooling, water (40 ml.) was added and the solution then contained 29.3% by weight of 2 - dimethylamino - 4 - methyl - 5 - *n* - butyl - 6 - hydroxypyrimidine in the form of the hydrochloride thereof.

- 5
75
10 In exactly the same manner an aqueous solution of the hydrochloride of 2 - ethylamino - 4 - methyl - 5 - *n* - butyl - 6 - hydroxypyrimidine (Compound No. 30 of Table I) was prepared.

EXAMPLE 3.

- 15 This Example illustrates the preparation of an aqueous solution of the nitric acid salt of 2 - dimethylamino - 4 - methyl - 5 - *n* - butyl - 6 - hydroxypyrimidine (Compound No. 4 of Table I). 2 - Dimethylamino - 4 - methyl - 5 - *n* - butyl - 6 - hydroxypyrimidine (10 g.) is dissolved in water (30 ml.) and nitric acid added (4.3 g. of a 70% w/v solution). The mixture was warmed until all the solid had dissolved and then water (100 ml.) added to yield a solution containing 13.1% w/v of 2 - dimethylamino - 4 - methyl - 5 - *n* - butyl - 6 - hydroxypyrimidine in the form of the nitric acid salt thereof.

EXAMPLE 4.

- 30 In a similar manner to that described in Example 3 aqueous solutions of the sulphuric acid and phosphoric acid salts, respectively, of 2 - dimethylamino - 4 - methyl - 5 - *n* - butyl - 6 - hydroxypyrimidine were obtained, using corresponding amounts respectively, of sulphuric acid and phosphoric acid instead of nitric acid. The resultant solutions contained 12.3% w/v and 14.7% w/v respectively, of the sulphuric and phosphoric acid salts of 2 - dimethylamino - 4 - methyl - 5 - *n* - butyl - 6 - hydroxypyrimidine.

EXAMPLE 5.

- 110 This Example illustrates the preparation of the potassium salt of 2 - dimethylamino - 4 - methyl - 5 - *n* - butyl - 6 - hydroxypyrimidine (Compound No. 4 of Table I).

- 115 2 - Dimethylamino - 4 - methyl - 5 - *n* - butyl - 6 - hydroxypyrimidine (4 g.) was dissolved in absolute ethanol (30 ml.) with warming and the resultant solution added to a solution of potassium hydroxide (1.16 g.) in absolute ethanol (25 ml.). The mixture was stirred for one hour at room temperature and the solvent then evaporated off leaving a white solid which was dried at 100°C. over phosphorus pentoxide. The solid was the potassium salt of 2 - dimethylamino - 4 - methyl - 5 - *n* - butyl - 6 - hydroxypyrimidine, m.p. 310°—316°C. (with decomposition).

EXAMPLE 6.

- 60 This Example illustrates the preparation of the sodium salt of 2 - dimethylamino - 4 -

methyl - 5 - *n* - butyl - 6 - hydroxypyrimidine (Compound No. 4 of Table I).

2 - Dimethylamino - 4 - methyl - 5 - *n* - butyl - 6 - hydroxypyrimidine (4 g.) was dissolved in absolute ethanol (30 ml.) with warming and the resultant solution added to a solution of metallic sodium (0.44 g.) in absolute ethanol (25 ml.). The mixed solutions were warmed to 50°C. for one hour whereafter the solvent was removed by evaporation leaving a white solid consisting of the sodium salt of 2 - dimethylamino - 4 - methyl - 5 - *n* - butyl - 6 - hydroxypyrimidine which was dried at 100°C. over phosphorus pentoxide, m.p. 285°C. (with decomposition).

EXAMPLE 7.

This Example illustrates the preparation of the *p*-toluene sulphonate salt of the compound 5 - *n* - butyl - 2 - dimethylamino - 4 - hydroxy - 6 - methylpyrimidine.

To a hot solution of 5 - *n* - butyl - 2 - dimethylamino - 4 - hydroxy - 6 - methylpyrimidine (2.09 g., 0.01 mole) in ethanol (15 ml.) was added *p*-toluenesulphonic acid (1.60 g., 0.01 mole). The solution was heated under reflux for 30 seconds, filtered rapidly and the filtrate allowed to cool, whereupon the *p*-toluenesulphonate salt of the pyrimidine separated, m.p. 148°C.

EXAMPLE 8.

This Example illustrates the preparation of the fluoroborate of the compound 5 - *n* - butyl - 2 - dimethylamino - 4 - hydroxy - 6 - methylpyrimidine.

The pyrimidine derivative (2.09 g., 0.01 mole) was added to an aqueous solution of fluoroboric acid (10 ml. of N solution; 0.01 mole) and the mixture warmed to 70°C. to bring about solution. On cooling, colourless crystals, m.p. 122—123°, separated.

EXAMPLE 9.

This Example illustrates the preparation of the hydrobromide of the compound 5 - *n* - butyl - 2 - dimethylamino - 4 - hydroxy - 6 - methylpyrimidine.

To a solution of the pyrimidine derivative (2.09 g., 0.01 mole) in acetic acid (10 ml.) was added a solution of hydrogen bromide in acetic acid (2 ml. of 45% w/v solution). The solvent was removed in vacuo and the residue was triturated with petroleum ether. The crystalline product was filtered off and dried, m.p. 184—186°C.

EXAMPLE 10.

This Example illustrates the preparation of the thiocyanate of the compound 5 - *n* - butyl - 2 - dimethylamino - 4 - hydroxy - 6 - methylpyrimidine.

To a solution of the pyrimidine derivative (2.09 g., 0.01 mole) in N hydrochloric acid (10 ml.) was added a solution of potassium

thiocyanate (0.97 g., 0.01 mole) in water (5 ml.). The mixture was warmed briefly and filtered. On cooling, the thiocyanate salt separated, m.p. 129—130°C.

5 EXAMPLE 11.

This Example illustrates the preparation of di - (5 - n - butyl - 2 - dimethylamino - 4-hydroxy - 6 - pyrimidinyl)mercury.

10 5 - n - butyl - 2 - dimethylamino - 4-methyl - 6 - hydroxypyrimidine (2.09 g., 0.01 mole) was dissolved in N sodium hydroxide solution (10 ml.) by gently warming on the steam bath. To this solution was added a solution of mercuric chloride (1.37 g., 0.005 mole) in water (10 ml.) and ethanol (5 ml.).
15 A white precipitate was formed immediately, and this rapidly turned light brown. The mixture was diluted with water, and the product filtered off, washed with water, ethanol, and ether, and finally dried, m.p. 202—205°C. (decomposition).
20

EXAMPLE 12.

25 This Example illustrates the preparation of the silver salt of the compound 5 - n - butyl - 2 - dimethylamino - 4 - methyl - 6 - hydroxypyrimidine.

To a solution of the pyrimidine derivative

(2.09 g., 0.01 mole) in N sodium hydroxide solution (10 ml.) was added an aqueous solution of silver nitrate (0.01 mole). The precipitated silver salt was filtered off, washed with water, ethanol, and ether, and dried, m.p. 190—194°C. (decomposition).

EXAMPLE 13.

This Example illustrates the preparation of the mercurichloride of the compound 5 - n - butyl - 2 - dimethylamino - 4 - methyl - 6-hydroxypyrimidine.

To a solution of the pyrimidine derivative (2.09 g., 0.01 mole) in N sodium hydroxide solution (10 ml.) was added with vigorous stirring a saturated solution of mercuric chloride (2.71 g., 0.01 mole) in ethanol. The brown precipitate which formed was filtered off after 10 minutes, washed with water, ethanol, and ether, and dried, m.p. 250—255°C. (soften 180°).
40
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EXAMPLES 14—18.

In a similar manner to the methods elucidated above the following further salts of the compound 2 - dimethylamino - 4 - methyl - 5 - n - butyl - 6 - hydroxypyrimidine were prepared.
50

Example No.	Salt	Physical Characteristics
14	Oxalate	m.p. 132°C.
15	2,4,6-trinitrobenzene-sulphonate	m.p. 209—210°C.
16	3,5-dinitrobenzoate	m.p. 159°C.
17	Trichloroacetate	m.p. 95°C.
18	Picrate	m.p. 182—183°C.

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EXAMPLES 19—32.

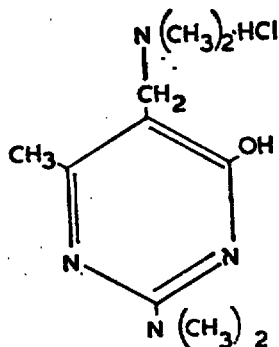
By using methods similar to those described in the preceding Examples the following salts

of the compound 2 - ethylamino - 4 - methyl-5 - *n* - butyl - 6 - hydroxypyrimidine were prepared:—

Example No.	Salt	Melting Point
19	Acid oxalate	182°C.
20	Oxalate	162—164°C.
21	p-toluenesulphonate	187°C.
22	2,4,6-trinitrobenzene sulphonate	215—218°C.
23	Trichloroacetate	118°C (with decomposition)
24	Citrate	154°C.
25	Picrate	247—249°C.
26	Hydrochloride	173—174°C.
27	Hydrobromide	201—202°C.
28	Perchlorate	96—97°C.
29	Thiocyanate	186—188°C.
30	Pyrimidinyl-mercuri-chloride	201°C. (with decomposition)
31	Di-pyrimidinyl-mercury	232—234°C.
32	Silver	250—255°C. (with decomposition)

EXAMPLE 33.

The compound 2 - dimethylamino - 5 - dimethylaminomethyl - 4 - hydroxy - 6 - methylpyrimidine hydrochloride, having the formula:—



was prepared as follows:—

15 A mixture of 2 - dimethylamino - 4 - hydroxy - 6 - methylpyrimidine (15.3 g., 0.1 mole), 37% formalin (0.1 mole) and dimethyl-

amine hydrochloride, (7.8 g., 0.1 mole) in ethanol (70 ml.) was refluxed for 2 hours. The solution was filtered hot and allowed to cool. The product (9.2 g.) was filtered off, sucked dry, and recrystallised from ethanol, m.p. 280—290°C.

EXAMPLE 34.

This Example illustrates the preparation of a water-soluble powder comprising 50%, by weight of the hydrochloride of Compound No. 4 of the Table I as the active ingredient.

The entire amount of the product produced by the method of Example I was ground together with potassium chloride (6.2 g.) to yield a powder which dissolves rapidly in water.

EXAMPLE 35.

This Example illustrates the preparation of a soluble powder comprising the potassium salt of Compound No. 4 of Table I as the active ingredient.

The potassium salt of 2 - dimethylamino-4 - methyl - 5 - *n* - butyl - 6 - hydroxypyrimidine (2.47 g.), prepared according to

Example 5, was mixed and ground with potassium sulphate (1.53 g.) to yield a powder which dissolves rapidly in water.

EXAMPLE 36.

- 5 This Example illustrates the preparation of a fungicidal composition in the form of an aqueous solution containing 1.2% by weight of the salt prepared in Example 5.

- 10 The potassium salt of 2 - dimethylamino-4 - methyl - 5 - *n* - butyl - 6 - hydroxypyrimidine (2.47 g.) prepared according to Example 5 is dissolved in water (200 ml.).

EXAMPLE 37.

- 15 This Example illustrates the preparation of a fertiliser composition comprising as active ingredient the salt of 2 - ethylamino - 4 - methyl - 5 - *n* - butyl - 6 - hydroxypyrimidine. The active ingredient was dissolved in trichloroethylene and the "TRILAC" added to this solution. The mixed solutions were then sprayed onto the fertiliser and the trichloroethylene was evaporated off. The proportions of the constituents in the product were as follows:—

- | | | |
|----|---|-------|
| 25 | I.C.I. No. 2 Fertiliser | 97.9% |
| | Potassium Salt of Compound No. 30 (Table I) | 0.3% |
| | "TRILAC" (registered Trade Mark) a solution of an alkyl resin | 1.8% |

- 30 In the following examples the words: 'LUBROL', 'AROMASOL', 'DISPERSOL', 'LISSAPOL', 'CELLOFAS' are Trade Marks.

EXAMPLE 38.

- 35 An emulsion concentrate was made up by mixing together the ingredients set out below in the proportions stated and stirring the mixture until all the constituents were dissolved.

- | | | |
|----|--|-----|
| 40 | Calciumdodecylbenzenesulphonate salt of Compound No. 4 | 15% |
| | Ethylene Dichloride | 40% |
| | 'LUBROL' L | 10% |
| | 'AROMASOL' H | 35% |

EXAMPLE 39.

- 45 A composition in the form of grains readily dispersible in a liquid, e.g. water, was prepared by grinding together the first three of the ingredients listed below in the presence of added water and then mixing in the sodium acetate. The resultant mixture was dried and passed through a British Standard mesh sieve, size 44—100, to obtain the desired size of grains.

- | | | |
|----|-----------------------------------|-------|
| 55 | Potassium salt of Compound No. 4. | 50% |
| | 'DISPERSOL' T | 25% |
| | 'LUBROL' APN5 | 1.5% |
| | Sodium acetate | 23.5% |

EXAMPLE 40.

The ingredients listed below were all ground together in the proportions stated to produce a powder formulation readily dispersible in liquids.

- | | | | |
|--|----------------------------------|-------|----|
| | Hydrochloride of Compound No. 4. | 45% | |
| | 'DISPERSOL' T | 5% | 65 |
| | 'LISSAPOL' NX | 0.5% | |
| | 'CELLOFAS' B600 | 2% | |
| | Sodium acetate | 47.5% | |

EXAMPLE 41.

Two active ingredient (Potassium salt of Compound No. 4 of Table I) was dissolved in a solvent and the resultant liquid was sprayed onto the granules of Fuller's earth. The solvent was then allowed to evaporate to produce a granular composition.

- | | | |
|--|---------------------------------------|-----|
| | Potassium salt of Compound No. 4 | 5% |
| | Fuller's earth or China clay granules | 95% |

EXAMPLE 42.

A composition suitable for use as a seed dressing was prepared by mixing all three of the constituents set out below in the proportions stated.

- | | | | |
|--|----------------------------------|-----|----|
| | Potassium salt of Compound No. 4 | 50% | |
| | Mineral Oil | 2% | 85 |
| | China clay | 48% | |

EXAMPLE 43.

A dusting powder was prepared by mixing, in the proportions stated, the active ingredient with talc.

- | | | | |
|--|---------------------------------|-----|----|
| | Hydrochloride of Compound No. 4 | 5% | |
| | Talc | 95% | 90 |

EXAMPLE 44.

This Example illustrates the utility of the invention in combating fungal infections.

Cucumber plants liable to infestation with powdery mildew (*Sphaerotheca fuliginea*) were employed. These plants, growing in a glasshouse in beds of loam-based compost at a density of 2500 plants/acre, were treated once with a 0.01% solution of 2 - dimethylamino-4 - methyl - 5 - *n* - butyl - 6 hydroxypyrimidine hydrochloride in water at a rate of 2.5 litres per plant. The plants remained free from mildew for eight weeks. A second treatment was then carried out at the same rate, and mildew infection was held in check for a further seven weeks. Compared with controls, a yield increase of 20 cucumbers per plant was obtained.

WHAT WE CLAIM IS:—

1) A fungicidal composition comprising as an active ingredient an acid addition salt or a metal salt of a pyrimidine derivative of the formula:—

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Example 5, was mixed and ground with potassium sulphate (1.53 g.) to yield a powder which dissolves rapidly in water.

EXAMPLE 36.

5 This Example illustrates the preparation of a fungicidal composition in the form of an aqueous solution containing 1.2% by weight of the salt prepared in Example 5.

10 The potassium salt of 2 - dimethylamino-4 - methyl - 5 - *n* - butyl - 6 - hydroxypyrimidine (2.47 g.) prepared according to Example 5 is dissolved in water (200 ml.).

EXAMPLE 37.

15 This Example illustrates the preparation of a fertiliser composition comprising as active ingredient the salt of 2 - ethylamino - 4 - methyl - 5 - *n* - butyl - 6 - hydroxypyrimidine. The active ingredient was dissolved in trichloroethylene and the "TRILAC" added to this solution. The mixed solutions were then sprayed onto the fertiliser and the trichloroethylene was evaporated off. The proportions of the constituents in the product were as follows:—

25 I.C.I. No. 2 Fertiliser 97.9%
Potassium Salt of Compound No. 30 (Table I) 0.3%
"TRILAC" (registered Trade Mark) a solution of an alkyd resin 1.8%

30 In the following examples the words: 'LUBROL', 'AROMASOL', 'DISPERSOL', 'LISSAPOL', 'CELLOFAS' are Trade Marks.

EXAMPLE 38.

35 An emulsion concentrate was made up by mixing together the ingredients set out below in the proportions stated and stirring the mixture until all the constituents were dissolved.

40 Calciumdodecylbenzenesulphonate salt of Compound No. 4 15%
Ethylene Dichloride 40%
'LUBROL' L 10%
'AROMASOL' H 35%

EXAMPLE 39.

45 A composition in the form of grains readily dispersible in a liquid, e.g. water, was prepared by grinding together the first three of the ingredients listed below in the presence of added water and then mixing in the sodium acetate. The resultant mixture was dried and passed through a British Standard mesh sieve, size 44—100, to obtain the desired size of grains.

55 Potassium salt of Compound No. 4. 50%
'DISPERSOL' T 25%
'LUBROL' APN5 1.5%
Sodium acetate 23.5%

EXAMPLE 40.

The ingredients listed below were all ground together in the proportions stated to produce a powder formulation readily dispersible in liquids. 60

Hydrochloride of Compound No. 4. 45%
'DISPERSOL' T 5% 65
'LISSAPOL' NX 0.5%
'CELLOFAS' B600 2%
Sodium acetate 47.5%

EXAMPLE 41.

Two active ingredient (Potassium salt of Compound No. 4 of Table I) was dissolved in a solvent and the resultant liquid was sprayed onto the granules of Fuller's earth. The solvent was then allowed to evaporate to produce a granular composition. 70 75

Potassium salt of Compound No. 4 5%
Fuller's earth or China clay granules 95% 10

EXAMPLE 42.

A composition suitable for use as a seed dressing was prepared by mixing all three of the constituents set out below in the proportions stated. 80 15

Potassium salt of Compound No. 4 50%
Mineral Oil 2% 85
China clay 48%

EXAMPLE 43.

A dusting powder was prepared by mixing, in the proportions stated, the active ingredient with talc. 90 25

Hydrochloride of Compound No. 4 5%
Talc 95%

EXAMPLE 44.

This Example illustrates the utility of the invention in combating fungal infections. 95 30

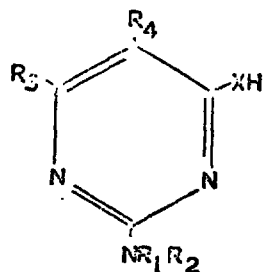
Cucumber plants liable to infestation with powdery mildew (*Sphaerotheca fuliginea*) were employed. These plants, growing in a glasshouse in beds of loam-based compost at a density of 2500 plants/acre, were treated once with a 0.01% solution of 2 - dimethylamino-4 - methyl - 5 - *n* - butyl - 6 hydroxypyrimidine hydrochloride in water at a rate of 2.5 litres per plant. The plants remained free from mildew for eight weeks. A second treatment was then carried out at the same rate, and mildew infection was held in check for a further seven weeks. Compared with controls, a yield increase of 20 cucumbers per plant was obtained. 100 35 105 40

WHAT WE CLAIM IS:—

1) A fungicidal composition comprising as an active ingredient an acid addition salt or a metal salt of a pyrimidine derivative of the formula:— 110 115



* C L M S *



or an acid addition salt of an ether thereof, wherein R₁ and R₂ are:

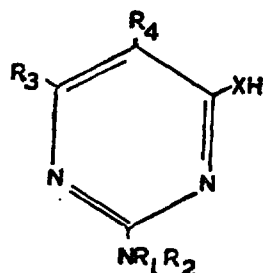
- hydrogen,
- 5 a substituted or unsubstituted hydrocarbon,
- a heterocyclic ring,
- 75 a benzylidene-imino group,
- an amino or sulphur-free substituted amino group,
- 10 a cyano group,
- a substituted or unsubstituted carbamoyl group,
- 80 an R·CO— or R·SO₂— group where R is a substituted or unsubstituted hydrocarbon group,
- 15 or R₁ and R₂, together with the adjacent N-atom, form a substituted or unsubstituted heterocyclic ring which may contain one or more additional heterocyclic atoms:

and wherein R₃ and R₄ are:

- hydrogen,
- halogen,
- a substituted or unsubstituted hydrocarbon group bonded directly to a carbon atom of the pyrimidine ring or through an O— or S— atom thereto,
- 25 a heterocyclic-substituted alkyl radical,
- a nitro group,
- 30 an azophenyl group,
- 95 an alkylsulphonyl group,

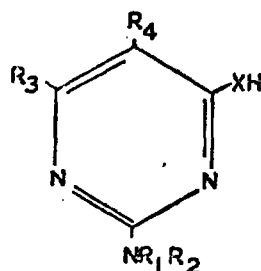
or R₃ and R₄ together form a substituted or unsubstituted alkylene or alkenylene bridging group; and wherein X is an atom of oxygen or sulphur; and a carrier for the active ingredient comprising a solid diluent, or a liquid diluent containing a surface active agent.

2) A fungicidal composition comprising as an active ingredient an acid addition salt or a metal salt of a pyrimidine derivative of the formula:—



or an acid addition salt of an ether thereof, wherein R₁ is hydrogen, alkyl, or substituted or unsubstituted aralkyl; R₂ is hydrogen, alkyl, alkenyl, unsubstituted aryl or halo-, alkyl-, or alkoxy-carbonyl-substituted aryl, unsubstituted or sulphur-free substituted amino, cyano, alkyl-carbonyl, halcalkylcarbonyl, heterocyclic, heterocyclic-substituted alkyl, carbamoyl, or R₁ and R₂ together with the adjacent N-atom form a heterocyclic ring which may contain one or more additional heterocyclic atoms; R₃ and R₄ are hydrogen, halogen, alkyl, alkaryl, alkenyl, alkylthioalkyl, alkoxyalkyl, hydroxyhaloalkyl, nitro, heterocyclic-substituted alkyl which may contain an N-atom, unsubstituted or substituted aryl or aryloxy, or arylthio, azophenyl, alkylamino, or alkylsulphonyl; and X is an atom of oxygen or sulphur; and a carrier for the active ingredient comprising a solid diluent, or a liquid diluent containing a surface active agent.

3) A fungicidal composition comprising as an active ingredient an acid addition salt or a metal salt of a pyrimidine derivative of the formula:—

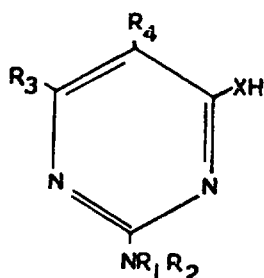


or an acid addition salt of an ether thereof, wherein R₁ and R₂ are hydrogen or lower alkyl groups, or R₁ and R₂ together with the adjacent nitrogen atom form a heterocyclic ring; R₃ is a lower alkyl group; R₄ is a lower alkyl or alkenyl group; and X is an atom of oxygen or sulphur; and a carrier for the active ingredient comprising a solid diluent, or a liquid diluent containing a surface active agent.

4) A fungicidal composition according to Claim 3 wherein the active ingredient is an acid addition salt or a metal salt of a compound in which R₁, R₂ and R₃ are methyl or ethyl groups; R₄ is an alkyl or alkenyl group containing from one to five carbon atoms; and X is an atom of oxygen or sulphur.

5) A fungicidal composition according to any of claims 1 to 4 wherein the active ingredient is a salt of a pyrimidine derivative as defined and in which the group —XH is etherified having an ether group comprising an alkyl, hydroxyalkyl, aralkyl, alkenyl, alkoxy-carbonylalkyl, alkylcarbonylalkyl, alkylamino-alkyl, or alkylthioalkyl residue.

6) Acid addition salts and metal salts of a pyrimidine derivative of the formula:—



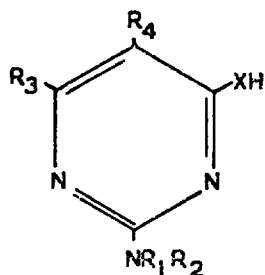
and acid addition salts of an ether thereof, wherein R₁ and R₂ are:

- 5 hydrogen,
- alkyl,
- alkenyl
- haloaryl,
- alkaryl,
- alkoxycarbonylaryl,
- 10 substituted or unsubstituted aralkyl,
- unsubstituted aryl,
- a heterocyclic ring,
- a benzylidene-imino group,
- an amino or sulphur-free substituted amino
- 15 group,
- a cyano group,
- a substituted or unsubstituted carbamoyl group,
- an R-CO— or R-SO₂— group where R is
- 20 a substituted or unsubstituted hydrocarbon group,
- or R₁ and R₂, together with the adjacent N-atom, form a substituted or unsubstituted heterocyclic ring which may contain one or
- 25 more additional heterocyclic atoms;
- and wherein R₃ and R₄ are:

- hydrogen,
- a substituted or unsubstituted hydrocarbon
- 30 group bonded directly to a carbon atom of the pyrimidine ring or through an O— or S— atom thereto,
- a heterocyclic-substituted alkyl radical,
- a nitro group,
- an azophenyl group,
- 35 an alkylsulphonyl group;
- and wherein X is an atom of oxygen or sulphur;

- Provided that R₄ is not hydrogen when R₃ is hydrogen, or when R₁ and R₃ are alkyl
- 40 and R₂ is hydrogen or alkyl, and that R₁ and R₂ are not both hydrogen when R₃ and R₄ are both alkyl groups.

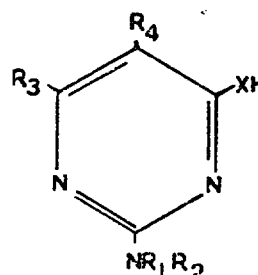
7) Acid addition salts and metal salts of a pyrimidine derivative of the formula:—



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and acid addition salts of an ether thereof, wherein R₁ is hydrogen, alkyl, or substituted or unsubstituted aralkyl; R₂ is hydrogen, alkyl, alkenyl, unsubstituted aryl or halo-, alkyl-, or alkoxycarbonyl-substituted aryl, unsubstituted or sulphur-free substituted amino, cyano, alkylcarbonyl, haloalkyl-carbonyl, heterocyclic, heterocyclic-substituted alkyl, carbamoyl, or R₁ and R₂ together with the adjacent N-atom form a heterocyclic ring which may contain one or more additional heterocyclic atoms; R₃ and R₄ are hydrogen, alkyl, alkaryl, alkenyl, alkylthioalkyl, alkoxy-alkyl, hydroxyhaloalkyl, nitro, heterocyclic substituted alkyl which may contain an N-atom, unsubstituted or substituted aryl or aryloxy, or arylthio, azophenyl, alkylamino, or alkylsulphonyl; X is an atom of oxygen or sulphur; provided that R₄ is not hydrogen when R₃ is hydrogen, or when R₁ and R₄ are alkyl and R₂ is hydrogen or alkyl, and that R₁ and R₂ are not both hydrogen when R₃ and R₄ are both alkyl groups.

8) Acid addition salts and metal salts of a pyrimidine derivative of the formula:—



and acid addition salts of an ether thereof, wherein R₁ and R₂ are hydrogen or lower alkyl groups, or R₁ and R₂ together with the adjacent nitrogen atom form a heterocyclic ring; R₃ is a lower alkyl group; R₄ is a lower alkyl or alkenyl group; X is an atom of oxygen or sulphur; provided that R₄ is not hydrogen when R₁, R₂ and R₃ are all alkyl groups and that R₁ and R₂ are not both hydrogen when R₃ and R₄ are both alkyl groups.

9) A salt of a pyrimidine derivative claimed in Claim 8 wherein the active ingredient is a compound in which R₁, R₂ and R₃ are methyl or ethyl groups; R₄ is an alkyl or alkenyl group containing from two to five carbon atoms; and X is an atom of oxygen or sulphur.

10) A salt of a pyrimidine derivative as claimed in any of claims 6 to 9 and in which the group —XH is etherified having an ether group comprising an alkyl, hydroxyalkyl, aralkyl, alkenyl, alkoxycarbonylalkyl, alkyl-carbonylalkyl, alkylaminoalkyl, or alkylthio-alkyl residue.

11) An acid addition or metal salt of 2-dimethylamino - 4 - methyl - 5 - n - butyl - 6 - hydroxypyrimidine.

12) An acid addition or metal salt of 2-

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ethylamino - 4 - methyl - 5 - *n* - butyl - 6-hydroxypyrimidine.

13) Salts of the compounds numbered 2, 3, 9, 12, 28, 37, 61, 69, 74, 90, 115, 116 and 125 in Tables I to III hereinbefore set forth.

14) A salt as claimed in any of claims 6 to 13 which is a hydrohalide or alkali metal salt.

15) A salt as claimed in any of claims 6 to 13 which is a hydrochloride.

16) A fungicidal composition comprising as an active ingredient a salt as claimed in any of claims 6 to 15, and a carrier.

17) A fungicidal composition comprising an aqueous solution of any of the salts claimed in any of claims 6 to 15.

18) A fungicidal composition as claimed in Claim 16 wherein a carrier is present which is a solid or liquid.

19) A fungicidal composition as claimed in Claim 16 wherein the carrier is water.

20) A fungicidal composition as claimed in any of claims 16 to 19 and comprising a wetting agent and/or a corrosion inhibitor.

21) A fungicidal composition as claimed in any of claims 1 to 5 or 16 to 19 containing from 0.001% to 85% by weight of the active ingredient.

22) A fungicidal composition as claimed in Claim 21 containing from 10 to 85% by weight of the active ingredient.

23) A fungicidal composition as claimed in Claim 21 containing from 0.001 to 10% by weight of the active ingredient.

24) A process for the preparation of salts of pyrimidine derivatives of Tables I to III substantially as described in any of Examples 1 to 33.

25) A salt of a pyrimidine derivative substantially as described in any of Examples 1 to 33.

26) A fungicidal composition containing as active ingredient a salt claimed in Claim 25 together with a diluent or carrier.

27) A fungicidal composition substantially as described, particularly with reference to Examples 34 to 43.

28) A method for the combating of undesired fungal infestations in growing plants which comprises applying to the locus of the plant a salt of a pyrimidine derivative as claimed in any of claims 6 to 15, or a fungicidal composition as claimed in any of claims 1 to 5 or 16 to 19.

29) A method of combating plant pathogens, in which a plant susceptible to such pathogens, or seed thereof, is treated with a salt of a pyrimidine derivative as defined in any of Claims 6 to 15 or a fungicidal composition as claimed in any of claims 1 to 5 or 16 to 19.

30) A fertiliser comprising a salt of a pyrimidine derivative as claimed in any of claims 6 to 15 or a fungicidal composition as claimed in any of claims 1 to 5 or 16 to 19.

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