

31,476-00

- 1 -

REPLACED SHEETS		SG
☒	Description : paged 16, 17, 18, 19 to paged -	
☒	Claim(s) : paged 13 to paged 107	
☐	Drawing(s) : paged to paged	
☐	Abstract : paged to paged	
DATE OF RECEIPT		

5

HALOALKYLTHIO, -SULFINYL AND -SULFONYL ARYLPYRROLE
INSECTICIDAL AND ACARICIDAL AGENTS

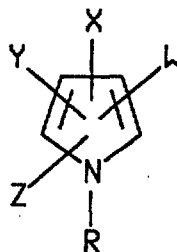
10

The present invention describes haloalkylthio, -sulfinyl and -sulfonyl arylpyrrole compounds that are highly effective insecticidal and acaricidal agents useful for the control of insect and acarid pests and for protecting agronomic crops from the ravages of said pests.

15

The haloalkylthio, -sulfinyl and -sulfonyl arylpyrrole compounds of the present invention have the structural formula I

20



25

(I)

wherein

W is $S(O)_n CF_2 R_1$;

30

R_1 is H, F, Cl, Br, CF_2H , CCl_2H , $CClFH$, CF_3 or CCl_3 ;

n is an integer of 0, 1 or 2;

X is phenyl optionally substituted with one to three halogen, C_1-C_3 alkyl, C_1-C_3 alkoxy, C_1-C_3 alkylthio, C_1-C_3 alkylsulfinyl, C_1-C_3 alkylsulfonyl, CN, NO_2 , CF_3 , R_2CF_2B , R_3CO or NR_4R_5 groups;

35

B is $S(O)_n$ or O;

This Sheet Has Been Replaced



R_2 is H, F, CF_2H , $CClFH$ or CF_3 ;
 R_3 is C_1-C_3 alkyl, C_1-C_3 alkoxy or NR_4R_5 ;
 R_4 is H or C_1-C_3 alkyl;
 R_5 is H or C_1-C_3 alkyl or R_6CO ;
5 R_6 is H or C_1-C_3 alkyl;
 Y is H, halogen, CF_3 , CN , NO_2 , $S(O)_nCF_2R_1$ or phenyl
optionally substituted with one to three halogen,
 C_1-C_3 alkyl, C_1-C_3 alkoxy, C_1-C_3 alkylthio, C_1-C_3
alkylsulfinyl, C_1-C_3 alkylsulfonyl, CN , NO_2 , CF_3 ,
10 R_2CF_2B , R_3CO or NR_4R_5 groups;
 Z is H, halogen or CF_3 ;

 R is H, CN , CR_7 , $R_8CHNHCR_9$, CH_2SO ,
 C_1-C_6 alkyl optionally substituted with one to
15 three halogen atoms,
one tri(C_1-C_4 alkyl)silyl,
one hydroxy,
one cyano,
one or two C_1-C_4 alkoxy groups optionally
20 substituted with one to three halogen
atoms,
one C_1-C_4 alkylthio,
one phenyl optionally substituted with one to
three halogen atoms, one to three C_1-C_4
25 alkyl groups or one to three C_1-C_4
alkoxy groups,
one phenoxy group optionally substituted with
one to three halogen atoms, one to three
 C_1-C_4 alkyl groups or one to three C_1-C_4
30 alkoxy groups,
one benzyloxy group optionally substituted on
the phenyl ring with one to three
halogen atoms, one to three C_1-C_4 alkyl
groups or one to three C_1-C_4 alkoxy
35 groups,



one C₁-C₆ alkylcarbonyloxy group optionally substituted with one to three halogen atoms,

5 one C₂-C₆ alkenylcarbonyloxy group optionally substituted with one to three halogen atoms,

10 one phenylcarbonyloxy group optionally substituted with one to three halogen atoms, one to three C₁-C₄ alkyl groups or one to three C₁-C₄ alkoxy groups,

one C₁-C₆ alkoxycarbonyl group optionally substituted with one to three halogen atoms or one to three C₁-C₄ alkoxy groups,

15 one benzylcarbonyloxy group optionally substituted on the phenyl ring with one to three halogen atoms, one to three C₁-C₄ alkyl groups or one to three C₁-C₄ alkoxy groups, or

20 one 2-furylcarbonyloxy group,

C₃-C₆ alkenyl optionally substituted with one to three halogen atoms or one phenyl group, or

25 C₃-C₆ alkynyl optionally substituted with one to three halogen atoms or one phenyl group;

R₇ is C₁-C₆ alkyl or C₃-C₆ cycloalkyl each optionally substituted with

one to three halogen atoms,

one hydroxy,

30 one cyano,

one or two C₁-C₄ alkoxy groups optionally substituted with one to three halogen atoms,

one C₁-C₄ alkylthio,

one phenyl group optionally substituted with one

35

This Sheet Has Been Replaced



to three halogen atoms, one to three C_1-C_4 alkyl groups or one to three C_1-C_4 alkoxy groups,

5 one phenoxy group optionally substituted with one to three halogen atoms, one to three C_1-C_4 alkyl groups or one to three C_1-C_4 alkoxy groups,

10 one benzyloxy group optionally substituted on the phenyl ring with one to three halogen atoms, one to three C_1-C_4 alkyl groups or one to three C_1-C_4 alkoxy groups,

one C_1-C_6 alkyl carbonyloxy group optionally substituted with one to three halogen atoms,

15 one C_2-C_6 alkenylcarbonyloxy group optionally substituted with one to three halogen atoms,

one phenylcarbonyloxy group optionally substituted with one to three halogen atoms, one to three C_1-C_4 alkyl groups or one to three C_1-C_4 alkoxy groups,

20 one C_1-C_6 alkoxy carbonyl group optionally substituted with one to three halogen atoms, or one to three C_1-C_4 alkoxy groups, or

one benzyloxy carbonyl group optionally substituted on the phenyl ring with one to three

25 halogen atoms, one to three C_1-C_4 alkyl groups or one to three C_1-C_4 alkoxy groups,

C_2-C_6 alkenyl optionally substituted with one to three halogen atoms or one phenyl group,

C_3-C_6 alkynyl optionally substituted with one to

30 three halogen atoms or one phenyl group,

phenyl optionally substituted with one to three halogen atoms, one to three C_1-C_4 alkyl groups, one C_5-C_{12} alkyl group, one to two C_1-C_4 alkoxy groups, or one phenoxy, C_1-C_4 alkylthio, tri-

35 alkylsilyl, C_1-C_4 alkylsulfinyl, C_1-C_4



alkylsulfonyl, carbo-C₁-C₄-alkoxy, carboxy, CF₃,
CN, NO₂, di(C₁-C₄ alkyl)amino, R₂CF₂B or C₁-C₄
alkanoylamino,

phenoxy optionally substituted with one to three

5 halogen atoms, one or two C₁-C₄ alkyl groups, one
or two C₁-C₄ alkoxy groups, trialkylsilyl, CF₃,
CN, NO₂, or di(C₁-C₄ alkyl)amino groups, or C₁-C₄
alkanoylamino,

1- or 2-naphthyl,

10 pyridyl, furyl, pyrrolyl or thiophenyl optionally
substituted with one to three halogen atoms,

C₁-C₆ alkoxy group optionally substituted with
one to three halogen atoms; or

C₂-C₆ alkenyloxy group optionally substituted with
15 one to three halogen atoms;

R₈ is hydrogen or C₁-C₄ alkyl;

R₉ is C₁-C₆ alkyl optionally substituted with one to
three halogen atoms,

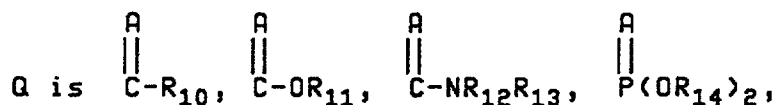
phenyl optionally substituted with one or two

20 halogen, CN, NO₂, C₁-C₄ alkyl, C₁-C₄ alkoxy
or CF₃ groups,

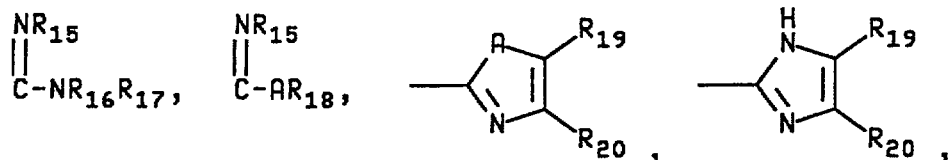
2- or 3-thienyl or

2- or 3-furyl;

25



30



35

This Sheet Has Been Replaced



CN, C₁-C₆ alkyl optionally substituted with one or more phenyl, CN or halogen groups or phenyl optionally substituted with one to three C₁-C₃ alkyl, C₁-C₃ alkoxy, halogen, CN, NO₂, CF₃ or NR₂₁R₂₂ groups;

A is O or S;

R₁₀ is C₁-C₆ alkyl or phenyl;

R₁₁ is C₁-C₆ alkyl;

R₁₂ and R₁₃ are each independently hydrogen, C₁-C₆ alkyl or when taken together with the atom to which they are attached may form a 5- to 7- membered ring wherein R₁₂R₁₃ represents from 4 to 6 hydrocarbons;

R₁₄ is C₁-C₄ alkyl;

R₁₅ is hydrogen, C₁-C₄ alkyl or may be taken together with either R₁₆ or R₁₈ and the atoms to which they are attached to form a 5- to 7-membered ring optionally substituted with one or two C₁-C₃ alkyl groups;

R₁₆ and R₁₇ are each independently hydrogen or C₁-C₄ alkyl;

R₁₈ is C₁-C₄ alkyl or when taken together with R₁₅ and the atoms to which they are attached may form a 5- to 7- membered ring optionally substituted with one or two C₁-C₃ alkyl groups;

R₁₉ and R₂₀ are each independently hydrogen or C₁-C₃ alkyl or when taken together may form a ring wherein R₁₉R₂₀ is represented by -C=C-C=C-; and

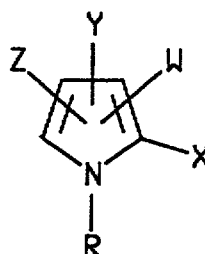
R₂₁ and R₂₂ are each independently hydrogen or C₁-C₃ alkyl.

The haloalkylthio, -sulfinyl and -sulfonyl arylpyrrole compounds of the present invention are excellent insecticidal and acaricidal agents. The present invention provides a method for controlling undesirable insects and acarina by applying an insecticidally or





acaricidally effective amount of a haloalkylthio, -sulfinyl or -sulfonyl arylpyrrole compound to the breeding grounds, food supply or habitat of said pests. Preferred haloalkylthio, -sulfinyl and -sulfonyl arylpyrroles have the structural formula II



(II)

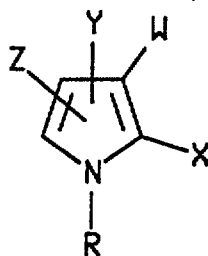
wherein W is $S(O)_n CF_2 R_1$;
X is phenyl substituted with one to three halogen, CN, NO_2 , CF_3 or $R_2 CF_2 B$ groups;
Y is Cl, Br, CF_3 , CN or $S(O)_n CF_2 R_1$;
Z is H, Cl, Br or CF_3 ;
R is H, CN, CR_7 or C_1-C_4 alkyl optionally substituted with one to three halogen atoms, one C_1-C_4 alkoxy group, one cyano, one C_1-C_6 alkylcarbonyloxy group, one phenylcarbonyloxy group optionally substituted with one to three halogen atoms or one C_1-C_4 alkyl group, one benzylcarbonyloxy group or one 2-furylcarbonyloxy group; and
 R_7 is phenyl optionally substituted with one to three halogen atoms, one or two C_1-C_4 alkyl groups, one or two C_1-C_4 alkoxy groups, CF_3 , CN, NO_2 or $R_2 CF_2 B$.

By the term halogen we intend an atom selected from the group consisting of F, Cl, Br and I.

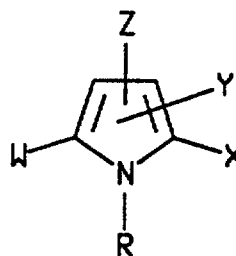
Preferred formula II compounds which are especially effective as insecticidal and/or acaricidal agents are illustrated by formula III and formula IV



5



(III)

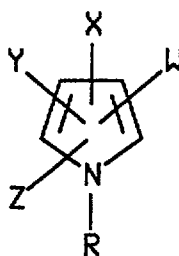


(IV)

- wherein W is SO_nCF_3 ;
 10 X is phenyl substituted with one to three halogen atoms or CF_3 ;
 Y is Cl, Br, CF_3 , CN or $\text{S(O)}_n\text{CF}_3$;
 Z is H, Cl, Br or CF_3 ; and
 R is H or $\text{C}_1\text{-C}_4$ alkyl substituted with one $\text{C}_1\text{-C}_4$ alkoxy
 15 group.

The present invention also relates to novel haloalkylthio, -sulfinyl and -sulfonyl arylpyrrole compounds having the structural formula V

20



25

(VIII)

- wherein
 W is $\text{S(O)}_n\text{CF}_2\text{R}_1$;
 R₁ is H, F, Cl, Br, CF_2H , CCl_2H , CClFH , CF_3 or CCl_3 ;
 30 n is an integer of 0, 1 or 2;
 X is phenyl substituted with one to three halogen, $\text{C}_1\text{-C}_3$ alkyl, $\text{C}_1\text{-C}_3$ alkoxy, $\text{C}_1\text{-C}_3$ alkylthio, $\text{C}_1\text{-C}_3$ alkylsulfinyl, $\text{C}_1\text{-C}_3$ alkylsulfonyl, CN, NO_2 , CF_3 , $\text{R}_2\text{CF}_2\text{B}$, R_3CO or NR_4R_5 groups;
 35 B is S(O)_n or O;



- R_2 is H, F, CF_2H , $CClFH$ or CF_3 ;
 R_3 is C_1-C_3 alkyl, C_1-C_3 alkoxy or NR_4R_5 ;
 R_4 is H or C_1-C_3 alkyl;
 R_5 is H or C_1-C_3 alkyl or R_6CO ;
5 R_6 is H or C_1-C_3 alkyl;
 Y is H, halogen, CF_3 , CN, NO_2 , $S(O)_nCF_2R_1$ or phenyl
substituted with one to three halogen, C_1-C_3
alkyl, C_1-C_3 alkoxy, C_1-C_3 alkylthio, C_1-C_3
alkylsulfinyl, C_1-C_3 alkylsulfonyl, CN, NO_2 , CF_3 ,
10 R_2CF_2B , R_3CO or NR_4R_5 groups;
 Z is H, halogen or CF_3 ;

 R is H, CN, CR_7 , $R_8CHNHCR_9$, CH_2SO ,
 C_1-C_6 alkyl optionally substituted with one to
15 three halogen atoms,
one tri(C_1-C_4 alkyl)silyl,
one hydroxy,
one cyano,
one or two C_1-C_4 alkoxy groups optionally
20 substituted with one to three halogen
atoms,
one C_1-C_4 alkylthio,
one phenyl optionally substituted with one to
three halogen atoms, one to three C_1-C_4
25 alkyl groups or one to three C_1-C_4
alkoxy groups,
one phenoxy group optionally substituted with
one to three halogen atoms, one to three
 C_1-C_4 alkyl groups or one to three C_1-C_4
30 alkoxy groups,
one benzyloxy group optionally substituted on
the phenyl ring with one to three
halogen atoms, one to three C_1-C_4 alkyl
groups or one to three C_1-C_4 alkoxy
35 groups,



- one C_1-C_6 alkylcarbonyloxy group optionally substituted with one to three halogen atoms,
- 5 one C_2-C_6 alkenylcarbonyloxy group optionally substituted with one to three halogen atoms,
- 10 one phenylcarbonyloxy group optionally substituted with one to three halogen atoms, one to three C_1-C_4 alkyl groups or one to three C_1-C_4 alkoxy groups,
- 15 one C_1-C_6 alkoxy carbonyl group optionally substituted with one to three halogen atoms or one to three C_1-C_4 alkoxy groups,
- 20 one benzylcarbonyloxy group optionally substituted on the phenyl ring with one to three halogen atoms, one to three C_1-C_4 alkyl groups or one to three C_1-C_4 alkoxy groups, or
- 25 one 2-furylcarbonyloxy group,
- C_3-C_6 alkenyl optionally substituted with one to three halogen atoms or one phenyl group, or
- C_3-C_6 alkynyl optionally substituted with one to three halogen atoms or one phenyl group;
- 30 R_7 is C_1-C_6 alkyl or C_3-C_6 cycloalkyl each optionally substituted with
- one to three halogen atoms,
- one hydroxy,
- 35 one cyano,
- one or two C_1-C_4 alkoxy groups optionally substituted with one to three halogen atoms,
- one C_1-C_4 alkylthio,
- one phenyl group optionally substituted with one

to three halogen atoms, one to three C_1-C_4 alkyl groups or one to three C_1-C_4 alkoxy groups,

5 one phenoxy group optionally substituted with one to three halogen atoms, one to three C_1-C_4 alkyl groups or one to three C_1-C_4 alkoxy groups,

10 one benzyloxy group optionally substituted on the phenyl ring with one to three halogen atoms, one to three C_1-C_4 alkyl groups or one to three C_1-C_4 alkoxy groups,

one C_1-C_6 alkyl carbonyloxy group optionally substituted with one to three halogen atoms,

15 one C_2-C_6 alkenylcarbonyloxy group optionally substituted with one to three halogen atoms,

one phenylcarbonyloxy group optionally substituted with one to three halogen atoms, one to three C_1-C_4 alkyl groups or one to three C_1-C_4 alkoxy groups,

20 one C_1-C_6 alkoxy carbonyl group optionally substituted with one to three halogen atoms, or one to three C_1-C_4 alkoxy groups, or

one benzyloxy carbonyl group optionally substituted on the phenyl ring with one to three

25 halogen atoms, one to three C_1-C_4 alkyl groups or one to three C_1-C_4 alkoxy groups,

C_2-C_6 alkenyl optionally substituted with one to three halogen atoms or one phenyl group,

C_3-C_6 alkynyl optionally substituted with one to

30 three halogen atoms or one phenyl group,

phenyl optionally substituted with one to three halogen atoms, one to three C_1-C_4 alkyl groups, one C_5-C_{12} alkyl group, one to two C_1-C_4 alkoxy groups, or one phenoxy, C_1-C_4 alkylthio, tri-

35 alkylsilyl, C_1-C_4 alkylsulfinyl, C_1-C_4



alkylsulfonyl, carbo-C₁-C₄-alkoxy, carboxy, CF₃,
CN, NO₂, di(C₁-C₄ alkyl)amino, R₂CF₂B or C₁-C₄
alkanoylamino,

phenoxy optionally substituted with one to three

5 halogen atoms, one or two C₁-C₄ alkyl groups, one
or two C₁-C₄ alkoxy groups, trialkylsilyl, CF₃,
CN, NO₂, or di(C₁-C₄ alkyl)amino groups, or C₁-C₄
alkanoylamino,

1- or 2-naphthyl,

10 pyridyl, furyl, pyrrolyl or thiophenyl optionally
substituted with one to three halogen atoms,

C₁-C₆ alkoxy group optionally substituted with
one to three halogen atoms; or

15 C₂-C₆ alkenyloxy group optionally substituted with
one to three halogen atoms;

R₈ is hydrogen or C₁-C₄ alkyl;

R₉ is C₁-C₆ alkyl optionally substituted with one to
three halogen atoms,

20 phenyl optionally substituted with one or two
halogen, CN, NO₂, C₁-C₄ alkyl, C₁-C₄ alkoxy
or CF₃ groups,

2- or 3-thienyl or

2- or 3-furyl;

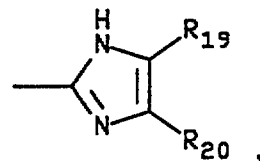
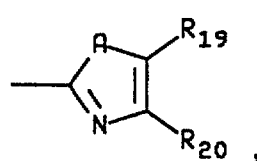
25

Q is $\begin{array}{c} \text{A} \\ \parallel \\ \text{C}-\text{R}_{10} \end{array}$, $\begin{array}{c} \text{A} \\ \parallel \\ \text{C}-\text{OR}_{11} \end{array}$, $\begin{array}{c} \text{A} \\ \parallel \\ \text{C}-\text{NR}_{12}\text{R}_{13} \end{array}$, $\begin{array}{c} \text{A} \\ \parallel \\ \text{P}(\text{OR}_{14})_2 \end{array}$,

30

$\begin{array}{c} \text{NR}_{15} \\ \parallel \\ \text{C}-\text{NR}_{16}\text{R}_{17} \end{array}$,

$\begin{array}{c} \text{NR}_{15} \\ \parallel \\ \text{C}-\text{AR}_{18} \end{array}$,



35

This Sheet Has Been Replaced



CN, C₁-C₆ alkyl optionally substituted with one or more phenyl, CN or halogen groups or phenyl optionally substituted with one to three C₁-C₃ alkyl, C₁-C₃ alkoxy, halogen, CN, NO₂, CF₃ or NR₂₁R₂₂ groups;

5 A is O or S;

R₁₀ is C₁-C₆ alkyl or phenyl;

R₁₁ is C₁-C₆ alkyl;

10 R₁₂ and R₁₃ are each independently hydrogen, C₁-C₆ alkyl or when taken together with the atom to which they are attached may form a 5- to 7- membered ring wherein R₁₂R₁₃ represents from 4 to 6 hydrocarbons;

R₁₄ is C₁-C₄ alkyl;

15 R₁₅ is hydrogen, C₁-C₄ alkyl or may be taken together with either R₁₆ or R₁₈ and the atoms to which they are attached to form a 5- to 7-membered ring optionally substituted with one or two C₁-C₃ alkyl groups;

20 R₁₆ and R₁₇ are each independently hydrogen or C₁-C₄ alkyl;

R₁₈ is C₁-C₄ alkyl or when taken together with R₁₅ and the atoms to which they are attached may form a 5- to 7- membered ring optionally substituted with

25 one or two C₁-C₃ alkyl groups;

R₁₉ and R₂₀ are each independently hydrogen or C₁-C₃ alkyl or when taken together may form a ring wherein R₁₉R₂₀ is represented by -C=C-C=C-; and

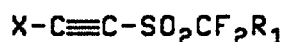
R₂₁ and R₂₂ are each independently hydrogen or C₁-C₃ alkyl;

30 provided that when R is H or C₁-C₆ alkyl, X is attached to a carbon atom adjacent to the pyrrole ring nitrogen atom; and when Y is substituted phenyl, X and Y cannot be attached to the pyrrole ring at positions two and

35 three.



Certain haloalkylsulfonyl arylpyrrole compounds of formula I, wherein W is $\text{SO}_2\text{CF}_2\text{R}_1$, Y, Z and R are H, and X and R_1 are as described above for formula I, may be prepared by reacting an arylethynyl halo-
5 alkylsulfonyl compound of formula VI



(IX)

wherein X and R_1 are as described above with at least
10 one molar equivalent of an aminoacetaldehyde di(C_1 - C_4 alkyl) acetal to give the appropriately substituted $\{\alpha\text{-}[(\text{haloalkylsulfonyl})\text{methylene}]\text{benzyl}\}\text{amino}\}$ acetaldehyde di(C_1 - C_4 alkyl) acetal of formula VII. The
15 formula VII intermediate is then reacted with excess trifluoroacetic acid to give the appropriately substituted 3-haloalkylsulfonyl-2-arylpyrrole of formula VIII. The above reaction scheme is shown below in Flow
Diagram I.

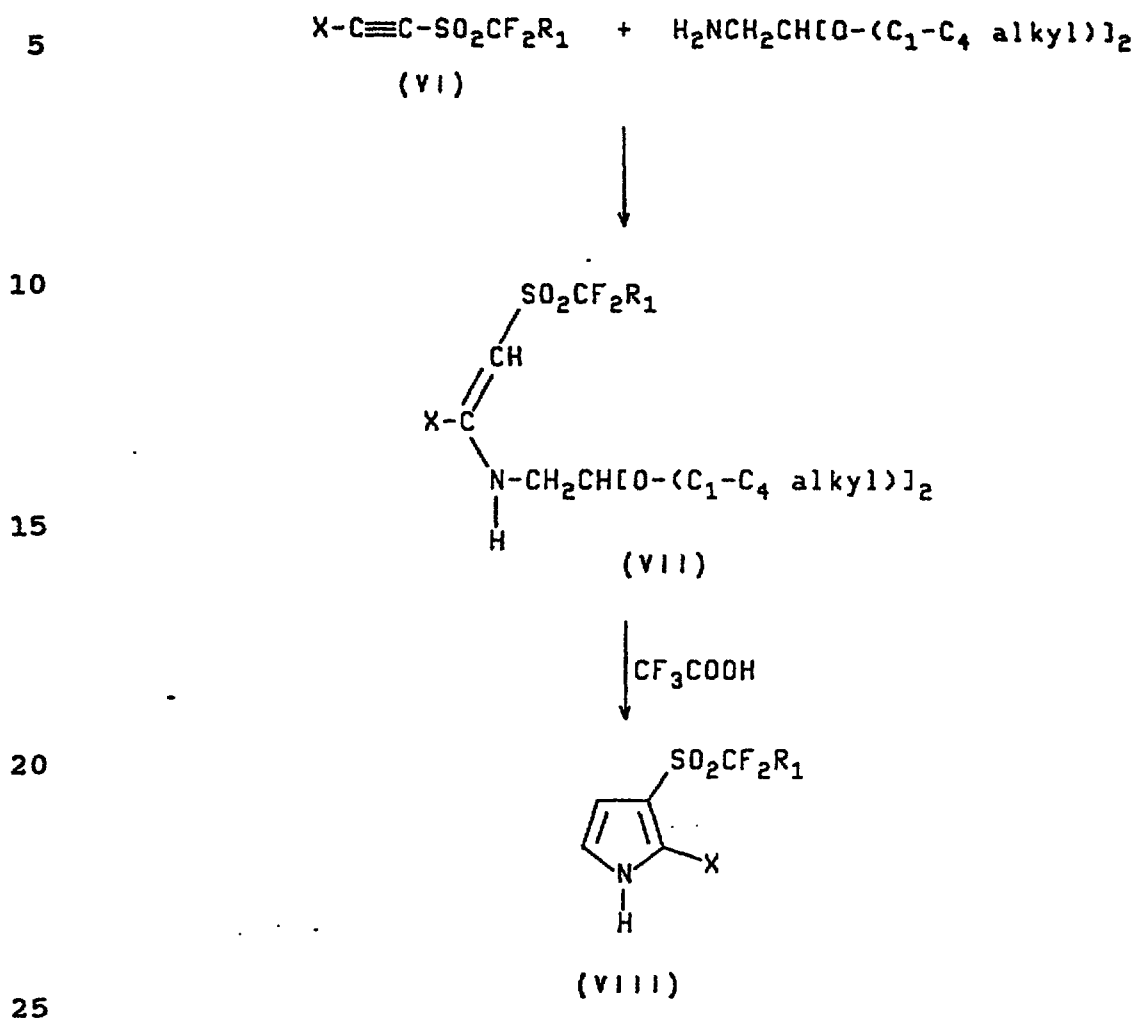
20

25

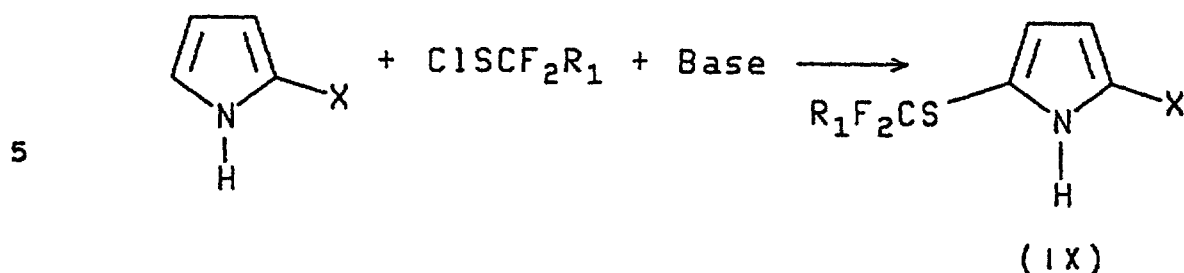
30

35

FLOW DIAGRAM I



Certain haloalkylthio arylpyrroles of formula I may be prepared by reacting a 2-arylpyrrole compound with an excess of a haloalkylsulfenyl chloride compound and at least one molar equivalent of a base to give the appropriately substituted 5-haloalkylthio-2-arylpyrrole compound of formula IX. This reaction may be illustrated as follows:



wherein X and R₁ are as described for formula I above.

10 Preparation of N-substituted formula I haloalkylthio, -sulfinyl and -sulfonyl arylpyrrole compounds can be achieved by reaction of the appropriately substituted formula I haloalkylthio-, -sulfinyl or -sulfonyl arylpyrrole having R as hydrogen

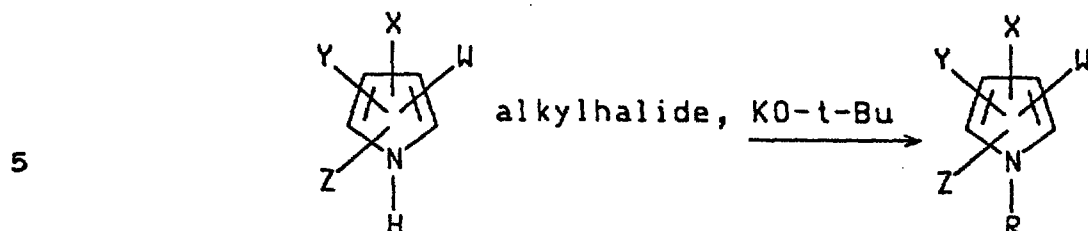
15 with an alkylating or acylating agent in the presence of an alkali metal alkoxide or hydride. For example, a formula I haloalkylthio, -sulfinyl or -sulfonyl arylpyrrole, wherein R is hydrogen and W, X, Y and Z are as described for formula I above, is reacted with an

20 appropriate alkylating agent such as a C₁-C₆ alkylhalide in which the alkyl group is straight or branched and is optionally substituted with from one to three halogen atoms, one hydroxy, one cyano, one C₁-C₄ alkoxy, one C₁-C₄ alkylthio, one phenyl group, optionally substituted with from one to three halogen atoms,

25 or one benzyloxy group, optionally substituted with from one to three halogen atoms, and an alkali metal alkoxide such as sodium or potassium *t*-butoxide. This reaction provides a haloalkylthio, -sulfinyl or -sulfonyl arylpyrrole having the same substituents as the starting material, but in addition is substituted on the nitrogen with a C₁-C₆ alkyl group optionally substituted as described above. This reaction may be

30 illustrated as follows:

35



10 wherein W, X, Y and Z are as described for formula I above and R is $\text{C}_1\text{-C}_6$ alkyl optionally substituted as described above. In a similar reaction cyanogen bromide is substituted for the alkylhalide and yields the formula I haloalkylthio, -sulfinyl or -sulfonyl arylpyrrole having a carbonitrile, rather than an alkyl group, on the nitrogen.

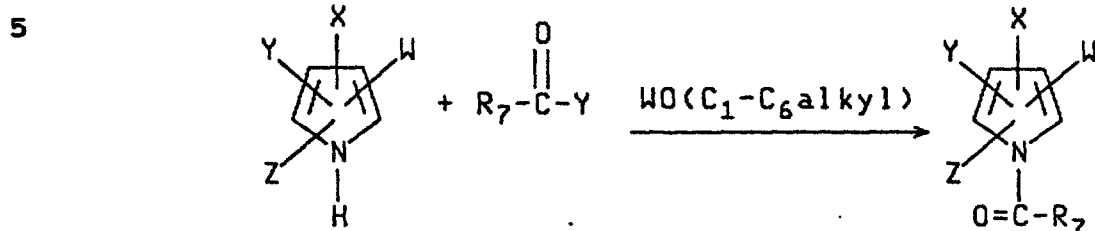
15 Advantageously, the above-described alkylation procedure of the formula I haloalkylthio, -sulfinyl or -sulfonyl arylpyrrole compounds, in which R is hydrogen may also be applied to the preparation of formula I haloalkylthio, -sulfinyl or -sulfonyl arylpyrroles having an $\text{N-C}_3\text{-C}_6$ alkenyl or $\text{N-C}_3\text{-C}_6$ alkynyl substituent. This N-substitution is obtained by simply substituting a $\text{C}_3\text{-C}_6$ alkenyl halide or $\text{C}_3\text{-C}_6$ alkynyl halide for the $\text{C}_1\text{-C}_6$ alkyl halide in the above-described reaction.

25 In a similar manner, preparation of N-acylated haloalkylthio, -sulfinyl or sulfonyl arylpyrrole compounds may be achieved by the reaction of an appropriately substituted formula I haloalkylthio, -sulfinyl or -sulfonyl arylpyrrole wherein R is hydrogen with an acylating agent in the presence of an alkali metal alkoxide. Acylating agents such as $\text{C}_1\text{-C}_6$ alkyl or $\text{C}_2\text{-C}_6$ alkenyl acid chloride, substituted $\text{C}_1\text{-C}_6$ alkyl or $\text{C}_2\text{-C}_6$ alkenyl acid chloride, benzoyl chloride, substituted benzoyl chloride, phenylchloroformate, substituted phenylchloroformate, $\text{C}_1\text{-C}_6$ alkyl or $\text{C}_2\text{-C}_6$ alkenylchloroformate, substituted $\text{C}_1\text{-C}_6$ alkyl or $\text{C}_2\text{-C}_6$

30

35

alkenylchloroformate, N-substituted carbamoyl chloride and the like may be employed. The reaction may be illustrated as follows:

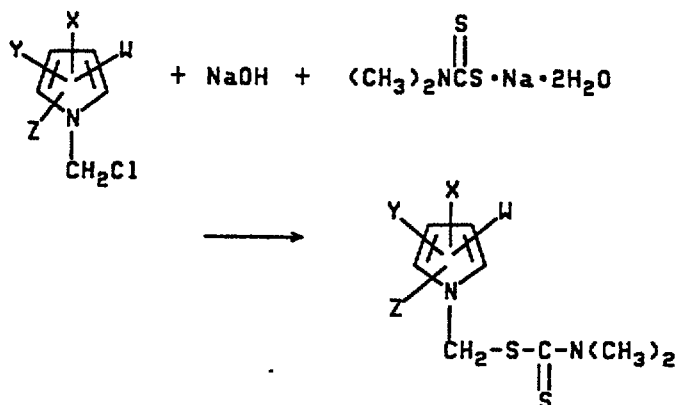


10 wherein Y is halogen, W is an alkali metal and W, X, Y, Z and R₇ are as described hereinabove for formula I.

N-substituted formula I haloalkylthio, -sulfinyl and -sulfonyl arylpyrrole compounds wherein R is CH₂SQ may be prepared by reaction of the appropriately substituted formula I haloalkylthio, -sulfinyl or -sulfonyl arylpyrrole having R as chloromethyl with an alkali metal salt of an SQ compound in the presence of a base. For example, a formula I haloalkylthio, -sulfinyl or -sulfonyl arylpyrrole, wherein R is chloromethyl and W, X, Y and Z are as described for formula I above, is reacted with sodium dimethyldithiocarbamate dihydrate and a base such as sodium hydroxide. This reaction provides a haloalkylthio, -sulfinyl or -sulfonyl arylpyrrole having the same substituents as the starting material, but in addition is substituted on the nitrogen with a methyl dimethyldithiocarbamate group. This reaction may be illustrated as follows:

30

35



wherein W, X, Y and Z are as described for formula I above.

The compounds of the present invention are effective for controlling insects and acarina. These compounds are also effective for protecting growing or harvested crops from attack by the above-said pests.

In practice generally about 10 ppm to 10,000 ppm and preferably 100 ppm to about 5,000 ppm of a formula I compound, dispersed in water, or another inexpensive liquid carrier, is effective when applied to the plants, the crops or the soil in which said crops are growing to protect said crops from attack by insects and acarina.

The formula I compounds of this invention are also effective for controlling insects and acarina, when applied to the foliage of plants and/or to the soil or water in which said plants are growing in sufficient amount to provide a rate of from about 0.100 kg/ha to 4.0 kg/ha of active ingredient.

While the compounds of this invention are effective for controlling insects and acarina when employed alone, they may also be used in combination with other biological chemicals, including other insecticides and acaricides. For example, the formula I compounds of this invention may be used effectively

in conjunction or combination with phosphates, carbamates, pyrethroids, formamidines, chlorinated hydrocarbons, halobenzoylureas and the like.

The compounds of the invention may be formulated as emulsifiable concentrates, flowable concentrates, or wettable powders which are diluted with water or other suitable polar solvent, generally in situ, and then applied as a dilute spray. Said compounds may also be formulated in dry compacted granules, granular formulations, dusts, dust concentrates, suspension concentrates, microemulsions and the like all of which lend themselves to seed, soil, water and/or foliage applications to provide the requisite plant protection. Such formulations include the compounds of the invention admixed with inert, solid or liquid diluents.

For example, wettable powders, dusts, and dust concentrate formulations can be prepared by grinding and blending together about 25% to about 85% by weight of formula I compounds and about 75% to about 15% by weight of a solid diluent such as bentonite, diatomaceous earth, kaolin, attapulgite, or the like, 1% to 5% by weight of a dispersing agent such as sodium lignosulfonate, and about 1% to 5% by weight of a nonionic surfactant, such as octylphenoxy polyethoxy ethanol, nonylphenoxy polyethoxy ethanol or the like.

A typical flowable liquid can be prepared by admixing about 30% to 90% by weight of a gelling agent such as bentonite, 2% to 5% by weight of a dispersing agent such as sodium ligosulfonate, about 1% by weight of polyethyleneglycol, and about 40% to 60% by weight of water.

A typical emulsifiable concentrate can be prepared by dissolving about 15% to 70% by weight of the active ingredient in about 85% to 30% by weight of

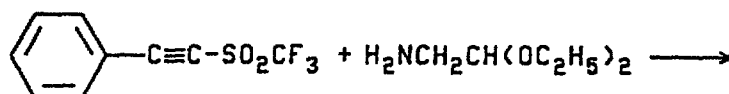
a solvent such as isophorone, toluene, butyl cello-solve, methyl acetate, propylene glycol monomethyl ether, or the like and dispersing therein about 1% to 5% by weight of a nonionic surfactant such as an alkylphenoxy polyethoxy alcohol.

Some of the examples provided by way of illustration below utilize the schemes illustrated above and others provide a means for preparing other compounds of the invention which are not specifically described hereinabove. The invention is not to be deemed limited thereby except as defined in the claims.

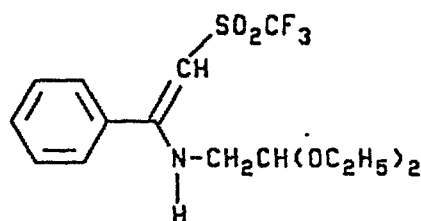
EXAMPLE 1

Preparation of ((α -([Trifluoromethyl)sulfonyl]methylene)benzyl)amino)acetaldehyde diethyl acetal

5



10



15

A solution of phenylethynyl trifluoromethylsulfone (2.43 g, 0.0104 mol) in ether is cooled to 5°C , treated with a solution of aminoacetaldehyde diethyl acetal (1.38 g, 0.0104 mol) in ether, stirred overnight at room temperature and concentrated in vacuo to obtain the title product as a red syrup (3.76 g) which is identified by NMR spectral analysis.

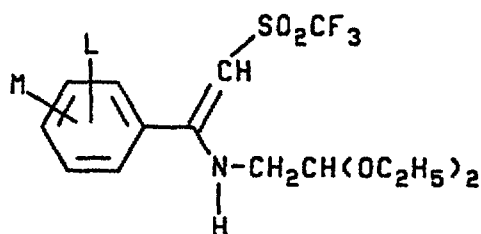
20

Following the above procedure, but substituting the appropriate substituted phenylethynyl trifluoromethylsulfone for phenylethynyl trifluoromethylsulfone yields the following compounds.

25

30

35



5

10

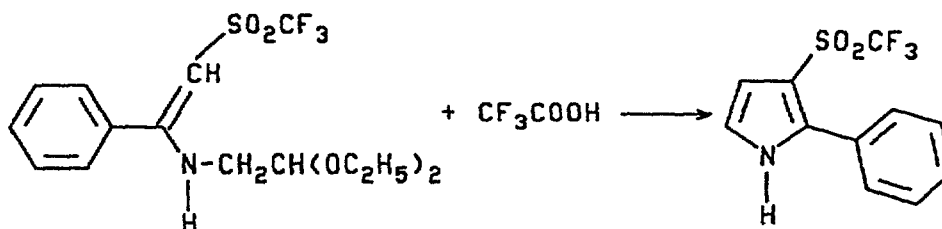
15

<u>L</u>	<u>M</u>
H	4-CH ₃
H	4-CN
H	4-Br
H	4-CF ₃
H	4-C(CH ₃) ₃
3-Cl	4-Cl
H	4-F
H	4-Cl

EXAMPLE 2

Preparation of 2-Phenyl-3-[(trifluoromethyl)sulfonyl]-pyrrole

20



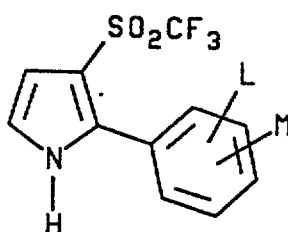
25

{{α-([(Trifluoromethyl)sulfonyl]methylene)-benzyl)amino}acetaldehyde diethyl acetal (3.3 g, 0.009 mol) is treated with trifluoroacetic acid (15 mL), stirred overnight at room temperature, concentrated in vacuo, and chased with ethyl acetate to obtain a brown oil. Flash chromatography of the oil using silica gel and a 1:4 ethyl acetate/hexanes solution gives a brown solid. The solid is triturated in hexanes, filtered and air dried to give the title

35

product as a tan solid (1.65 g, mp 116°-118°C) which is identified by ¹HNMR and ¹³CNMR spectral analyses.

Following the above procedure, but using the appropriately substituted ((α-((trifluoromethyl)sulfonyl)methylene)benzyl)amino)acetaldehyde diethyl acetal yields the following compounds.



	<u>M</u>	<u>R</u>	<u>mp°C</u>
15	H	4-CH ₃	101-103
	H	4-CN	oil
	H	4-Br	87-89
	H	4-CF ₃	semi-solid
	H	4-C(CH ₃) ₃	116-118
20	3-Cl	4-Cl	semi-solid
	H	4-F	120.5-124.5
	H	4-Cl	87-90

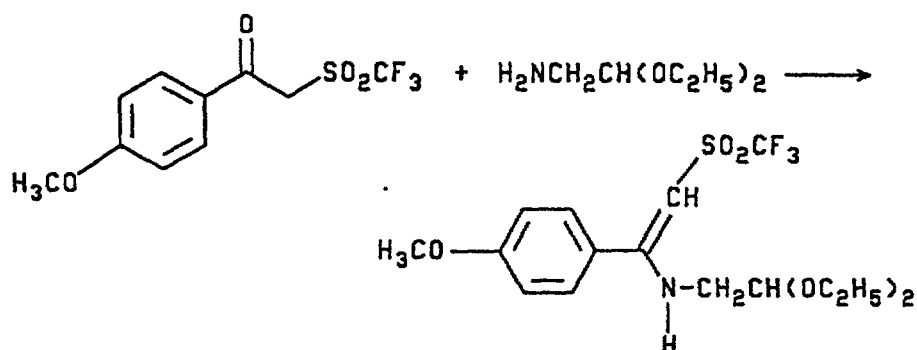


EXAMPLE 3

Preparation of 2-(p-Methoxy-α-[(trifluoromethyl)sulfonyl]methylene)benzylamino)acetaldehyde diethyl acetal

5

10



15

20

A solution of 4'-methoxy-2-[(trifluoromethyl)sulfonyl]acetophenone (6.0 g, 0.021 mol) in toluene is treated with aminoacetaldehyde diethyl acetal (2.8 g, 0.021 mol), heated at reflux overnight with removal of water, and concentrated in vacuo to obtain the title product as an oil. This oil is used in Example 4 without further purification.

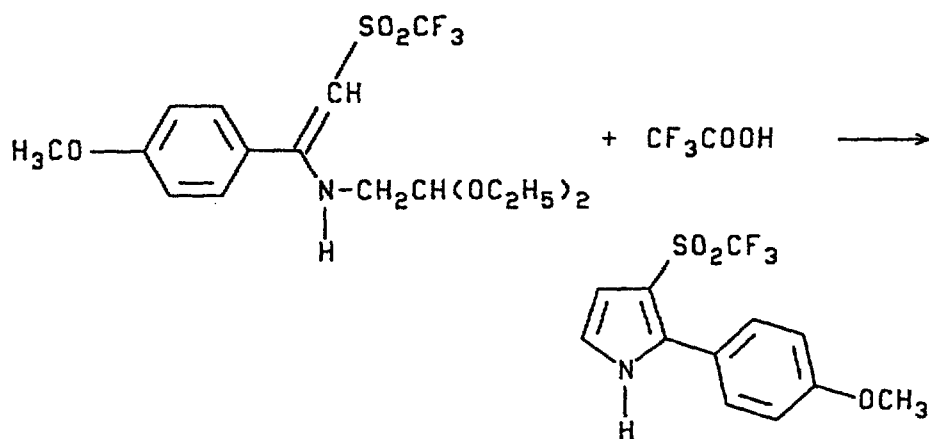
EXAMPLE 4

Preparation of 2-(p-Methoxyphenyl)-3-[(trifluoromethyl)sulfonyl]pyrrole

25

30

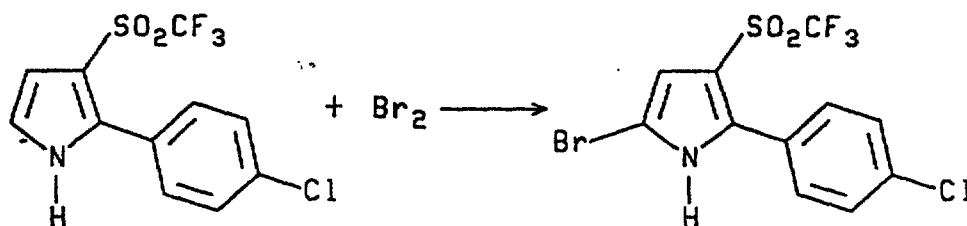
35



The oil obtained in Example 3 is treated with trifluoroacetic acid (20 mL), stirred for several hours at room temperature, concentrated in vacuo and chased with ethyl acetate to obtain an oil. Flash chromatography of the oil using silica gel and a 1:4 ethyl acetate/heptane solution gives a yellow semi-solid. Recrystallization of the semi-solid gives the title product as a yellow solid (0.88 g, mp 138.5°-140.5°C) which is identified by ¹HNMR and ¹³CNMR spectral analyses.

EXAMPLE 5

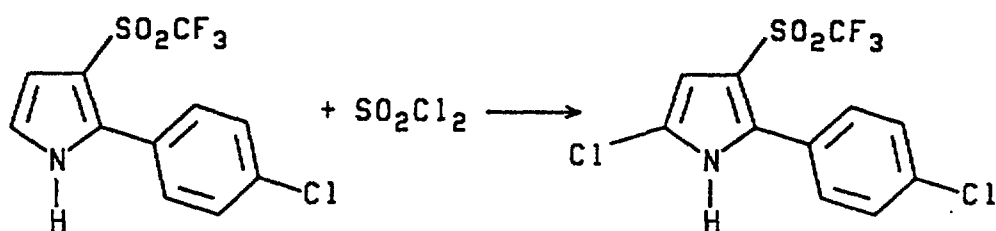
Preparation of 5-Bromo-2-(p-chlorophenyl)-3-[(tri-fluoromethyl)sulfonyl]pyrrole



A solution of 2-(p-chlorophenyl)-3-[(tri-fluoromethyl)sulfonyl]pyrrole (1.0 g, 0.00323 mol) in chloroform is cooled, treated with a solution of bromine (0.52 g, 0.00323 mol) in chloroform, stirred at room temperature overnight, diluted with chloroform, washed with water and brine, dried over anhydrous magnesium sulfate and concentrated in vacuo to obtain a dark syrup. Flash chromatography of the syrup using silical gel and a 1:5 ethyl acetate/hexanes solution gives the title product as an off-white solid (0.31 g, mp 73°-76°C) which is identified by ¹HNMR spectral analysis.

EXAMPLE 6

Preparation of 5-Chloro-2-(p-chlorophenyl)-3-[(tri-fluoromethyl)sulfonyl]pyrrole



15

A solution of 2-(p-chlorophenyl)-3-[(tri-fluoromethyl)sulfonyl]pyrrole (1.0 g, 0.00323 mol) in acetic acid is treated with thionyl chloride (0.43 g, 0.00323 mol), stirred for 30 minutes, poured into water and decanted to obtain a residue. The residue is dissolved in ethyl acetate and the organic solution is washed with brine, dried over anhydrous magnesium sulfate and concentrated in vacuo to obtain a dark syrup. Flash chromatography of the syrup using silica gel and a 1:5 ethyl acetate/hexanes solution gives the title product as a yellow solid (0.43 g, mp 109^o-112^oC) which is identified by ¹HNMR spectral analysis.

20

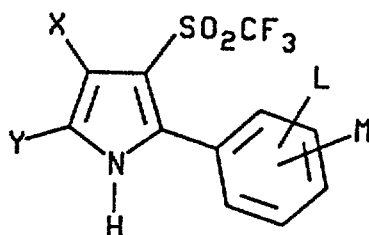
25

Following the procedures of Examples 5 and 6, but substituting the appropriately substituted 2-phenyl-3-[(trifluoromethyl)sulfonyl]pyrrole for 2-(p-chlorophenyl)-3-[(trifluoromethyl)sulfonyl]pyrrole and using one or two equivalents of halogenating reagent yields the following compounds.

30

35

5

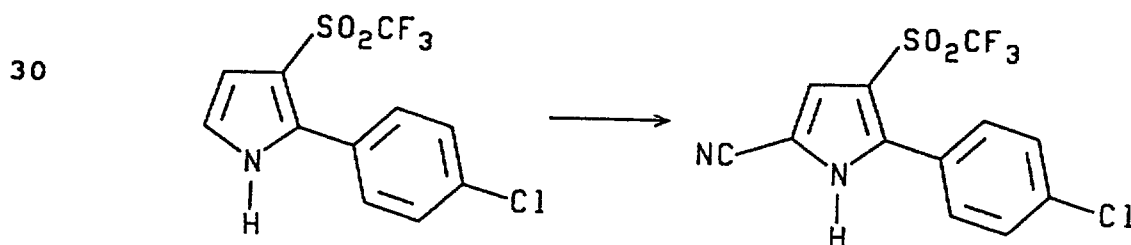


	<u>X</u>	<u>Y</u>	<u>L</u>	<u>M</u>	<u>mp^oC</u>
	Br	Br	H	4-Cl	149-150
10	Cl	Cl	H	4-Cl	140-143
	Br	Br	H	4-F	167-169
	Br	Br	3-Cl	4-Cl	148-149
	Br	Br	H	4-CH ₃	183.5-185
	Cl	Cl	3-Cl	4-Cl	147-149
15	Br	Br	H	4-CN	214-217
	H	Br	H	4-CN	syrup
	Cl	Cl	H	4-CH ₃	170-171
	Br	Br	H	H	158 (dec)
	Br	Br	H	4-Br	146-148
20	Br	Br	H	4-CF ₃	208-211
	Cl	Cl	H	4-Br	126-129
	Br	Br	H	4-C(CH ₃) ₃	195.5-196.5
	Br	Br	H	4-OCH ₃	138.5-150

25

EXAMPLE 7

Preparation of 5-(p-Chlorophenyl)-4-[(trifluoromethyl)-sulfonyl]pyrrole-2-carbonitrile



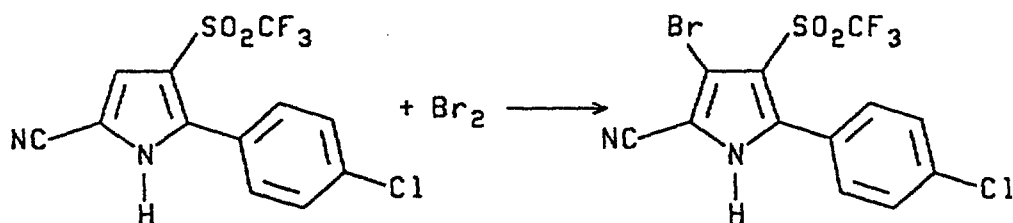
35

A solution of 2-(p-chlorophenyl)-3-[(tri-fluoromethyl)sulfonyl]pyrrole (0.9 g, 0.00291 mol) in

acetonitrile is cooled, treated with chlorosulfonyl isocyanate (0.66 g, 0.00465 mol) under nitrogen, stirred overnight at room temperature, cooled, treated with dimethylformamide (1.06 g, 0.0145 mol), stirred at room temperature for five hours, poured into water and extracted with ether. The combined organic extracts are washed with brine, dried over anhydrous magnesium sulfate and concentrated in vacuo to obtain a dark syrup. Flash chromatography of the syrup using silica gel and a 1:3 ethyl acetate/hexanes solution gives a pale yellow syrup which is placed onto a silica gel plate and eluted with a 1:3 ethyl acetate/hexanes solution to give the title product as a waxy solid (mp 112°-122°C) which is identified by ¹HNMR spectral analysis.

EXAMPLE 8

Preparation of 3-Bromo-5-(p-chlorophenyl)-4-[(tri-fluoromethyl)sulfonyl]pyrrole-2-carbonitrile

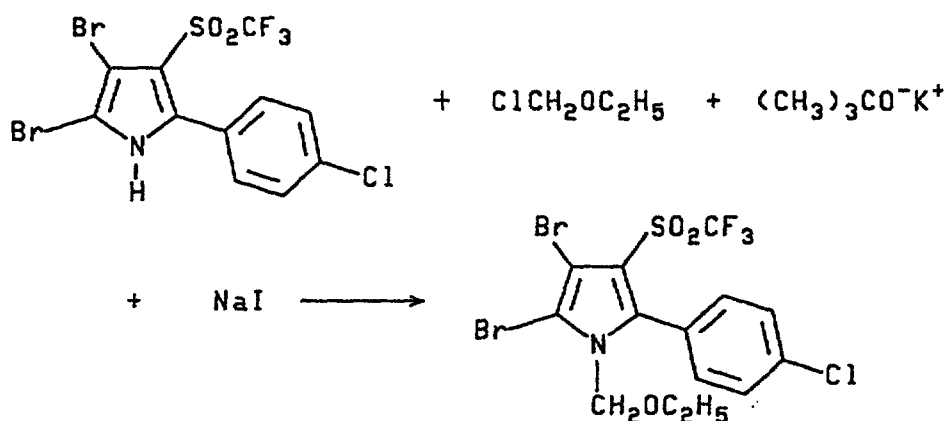


A solution of 5-(p-chlorophenyl)-4-[(tri-fluoromethyl)sulfonyl]pyrrole-2-carbonitrile (0.87 g, 0.0026 mol) in dioxane is cooled, treated with bromine (0.46 g, 0.00286 mol), stirred at room temperature for two hours, treated with additional bromine (0.21 g, 0.0013 mol), stirred overnight at room temperature, poured into water and extracted with ethyl acetate. The combined organic extracts are washed with water, saturated sodium meta-bisulfite solution and brine, dried over anhydrous magnesium sulfate and concentrated

in vacuo to obtain a yellow syrup. Flash chromatography of the syrup using silica gel and a 1:4 ethyl acetate/hexanes solution gives the title product as a tan solid (0.27 g, mp 170^o-185^oC) which is identified by ¹HNMR spectral analysis.

EXAMPLE 9

Preparation of 2,3-Dibromo-5-(p-chlorophenyl)-1-(ethoxymethyl)-4-[(trifluoromethyl)sulfonyl]pyrrole

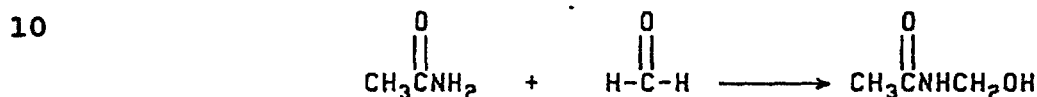


A solution of potassium tert-butoxide (0.62 g, 0.0055 mol) in tetrahydrofuran is treated with 2,3-dibromo-5-(p-chlorophenyl)-4-[(trifluoromethyl)sulfonyl]pyrrole (2.34 g, 0.005 mol), stirred for 15 minutes, treated with sodium iodide (0.82 g, 0.0055 mol), stirred for five minutes, treated with a solution of chloromethyl ethyl ether (0.52 g, 0.0055 mol) in tetrahydrofuran, stirred at room temperature for several hours, poured into water and extracted with ether. The combined organic extracts are washed with water and brine, dried over anhydrous sodium sulfate and concentrated in vacuo to give an orange oil. The oil is slurried in hexane and filtered to obtain the title product as a pale yellow solid (1.95 g, mp 133^o-135^oC) which is identified by ¹HNMR and ¹⁹FNMR spectral analyses.

Following the above procedure, but substituting bromoacetonitrile for chloromethyl ethyl ether yields 2,3-dibromo-5-(p-chlorophenyl-4-[(trifluoromethyl)sulfonyl]pyrrole-1-acetonitrile, mp 191.5°-193.5°C.

EXAMPLE 10

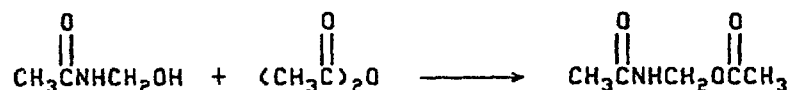
Preparation of N-(hydroxymethyl)acetamide



Acetamide (200 g, 3.4 mol) is added to a solution of potassium carbonate (20 g, 0.144 mol) in an aqueous formaldehyde solution (274 g, 37%, 3.4 mol). The reaction mixture is heated to 75°C, stirred for 3 1/2 hours at room temperature, quenched with dry ice, diluted with acetone, dried with anhydrous sodium sulfate and filtered. The filtrate is dried with anhydrous sodium sulfate, filtered and concentrated in vacuo to give the title product as an oil (309 g) which is identified by ¹HNMR spectral analysis.

EXAMPLE 11

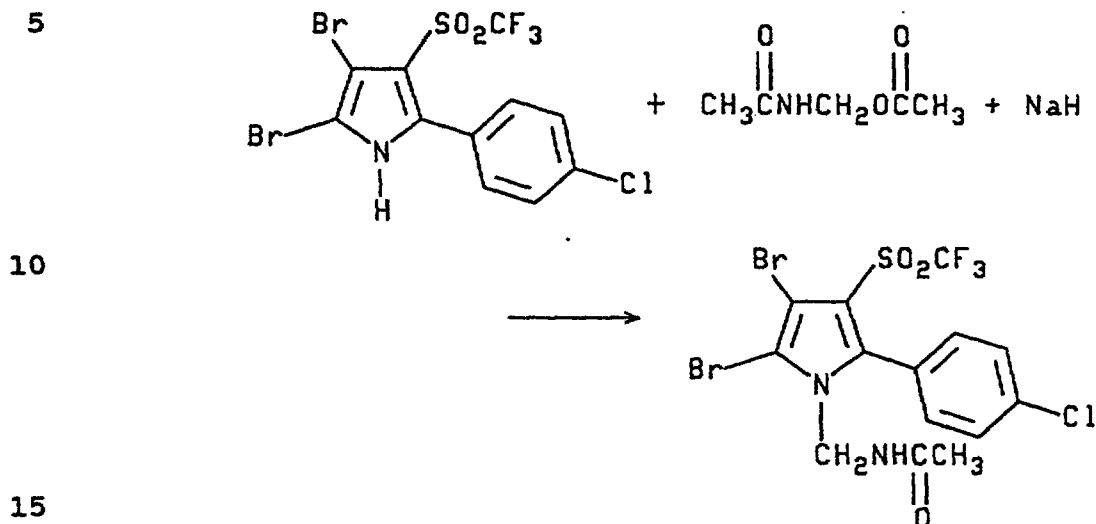
Preparation of N-(hydroxymethyl)acetamide acetate (ester)



Acetic anhydride (25 g) and pyridine (10 drops) is added to N-(hydroxymethyl)acetamide (9 g, 0.1 mol). The reaction mixture is stirred overnight at room temperature, concentrated in vacuo and chased with xylene to give the title product as an oil (11.9 g, 0.9 mol) which is identified by ¹HNMR spectral analysis.

EXAMPLE 12

Preparation of N-([2,3-Dibromo-5-(p-chlorophenyl)-4-
[(trifluoromethyl)sulfonyl]pyrrol-1-yl]methyl)acetamide



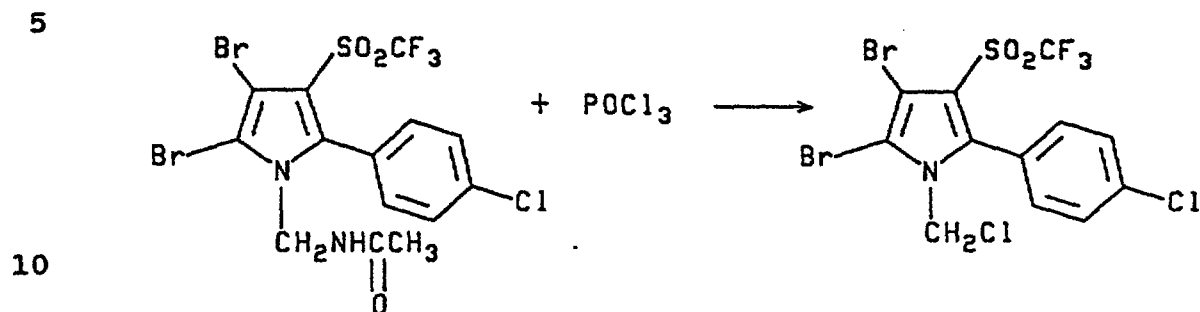
A mixture of sodium hydride (0.5 g, 60%, 0.0125 mol) and tetrahydrofuran is treated with 2,3-dibromo-5-(p-chlorophenyl)-4-[(trifluoromethyl)sulfonyl]pyrrole (4.67 g, 0.01 mol), stirred for 15 minutes and treated with a solution of N-(hydroxymethyl)acetamide acetate (ester) (1.64 g, 0.0125 mol) in tetrahydrofuran. The reaction mixture is heated at reflux for 18 hours, concentrated in vacuo and poured into a water/ether mixture. The organic phase is separated, washed with water and brine, dried over anhydrous sodium sulfate and concentrated in vacuo to obtain the title product as a white solid (4.56 g).

30

35

EXAMPLE 13

Preparation of 2,3-Dibromo-1-(chloromethyl)-5-(p-chlorophenyl)-4-[(trifluoromethyl)sulfonyl]pyrrole



15

20

25

30

35

N-((2,3-Dibromo-5-(p-chlorophenyl)-4-[(trifluoromethyl)sulfonyl]pyrrol-1-yl)methyl)acetamide (4.5 g, 0.00835 mol) is added to phosphorus oxychloride (15 mL). The reaction mixture is refluxed for 3 1/2 hours, poured into water, stirred overnight and filtered to obtain a solid. The solid is dissolved into methylene chloride and the solution is dried over anhydrous sodium sulfate and concentrated in vacuo to obtain the title product as a yellow solid (3.8 g, mp 153°-156°C) which is identified by ¹HNMR and ¹³CNMR spectral analyses.

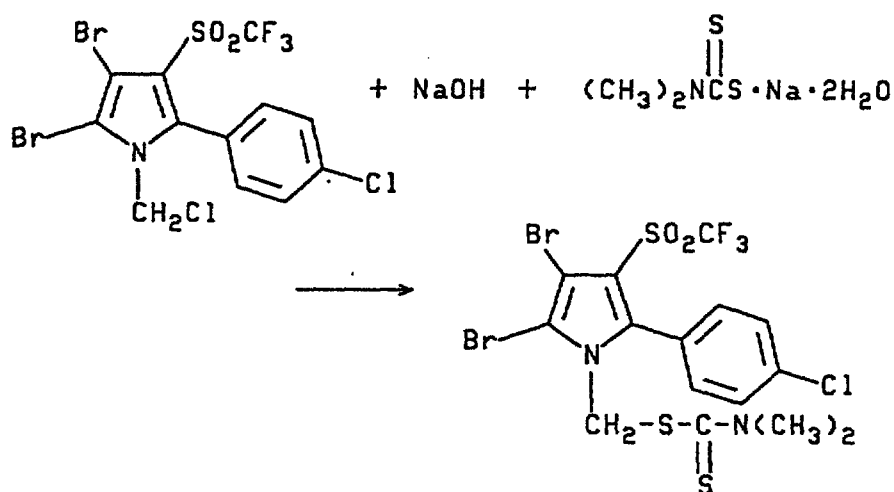
EXAMPLE 14

Preparation of (2,3-Dibromo-5-(p-chlorophenyl)-4-[(tri-fluoromethyl)sulfonyl]pyrrol-1-yl)methyl dimethyldi-thiocarbamate

5

10

15



20

25

30

2,3-Dibromo-1-(chloromethyl)-5-(p-chloro-phenyl)-4-[(trifluoromethyl)sulfonyl]pyrrole (1.0 g, 0.00194 mol) is added to a mixture of sodium hydroxide (0.084 g, 0.0021 mol), sodium dimethyldithiocarbamate dihydrate (0.376 g, 0.0021 mol) and dimethylformamide. The reaction mixture is stirred for six hours at room temperature, poured into water and extracted with ethyl acetate. The combined organic extracts are washed with water and brine, dried over anhydrous sodium sulfate and concentrated in vacuo to obtain a yellow gum. The gum is stirred with hexanes overnight and filtered to give the title product as a white solid (0.37 g, mp 185°-187°C) which is identified by ¹HNMR and ¹⁹FNMR spectral analyses.

35

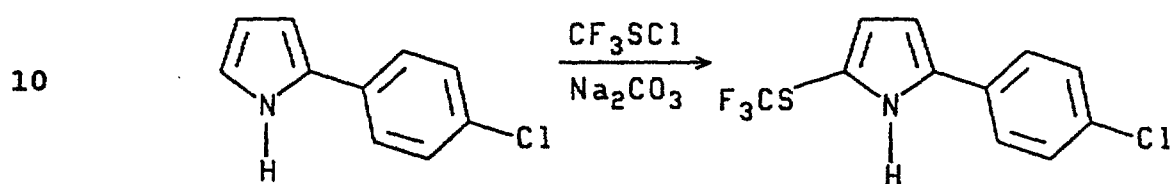
Following the above procedure, but using p-chlorohippuric acid and p-toluic acid for sodium dimethyldithiocarbamate dihydrate yields (2,3-dibromo-5-(p-chlorophenyl)-4-[(trifluoromethyl)sulfonyl]-pyrrole-1-yl)methyl p-chlorohippurate, mp 74°-78°C and

{2,3-dibromo-5-(p-chlorophenyl)-4-[(trifluoromethyl)-sulfonyl]pyrrol-1-yl)methyl p-toluate, mp 148°-151°C, respectively.

5

EXAMPLE 15

Preparation of 2-(p-Chlorophenyl)-5-[(trifluoromethyl)-thio]pyrrole



15

Trifluoromethylsulfenyl chloride is bubbled into a solution of 2-(p-chlorophenyl)pyrrole (0.5 g, 0.00281 mol) and sodium carbonate (0.36 g, 0.00338 mol) in ether at -30°C under nitrogen. The reaction mixture is stirred for 1/2 hour and diluted with a water/ether mixture. The organic phase is separated, washed with brine, dried over anhydrous magnesium sulfate and

20

concentrated in vacuo to give the title product as a purple solid (0.78 g, mp 34°-39°C) which is identified by ^1H NMR and ^{13}C NMR spectral analyses.

25

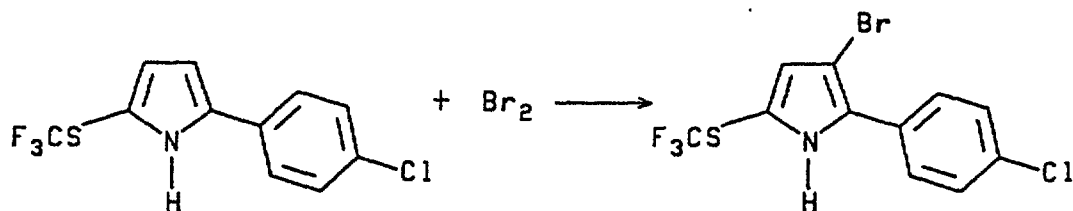
Following the above procedure, but substituting difluoromethylsulfenyl chloride for trifluoromethylsulfenyl chloride yields 2-(p-chlorophenyl)-5-[(difluoromethyl)thio]pyrrole, mp 42°-46°C.

30

35

EXAMPLE 16

Preparation of 3-Bromo-2-(p-chlorophenyl)-5-[(trifluoromethyl)thio]pyrrole



10 A solution of 2-(p-chlorophenyl)-5-[(tri-
fluoromethyl)thio]pyrrole (1.94 g, 0.00699 mol) in
chloroform is cooled, treated with a solution of
bromine (1.16 g, 0.00699 mol) in chloroform, stirred
15 for two hours, washed with water and brine, dried over
anhydrous magnesium sulfate and concentrated in vacuo
to obtain a dark syrup. Flash chromatography of the
syrup using silica gel and a 1:10 ethyl acetate/hexanes
solution gives the title product as a pink syrup
(2.0 g) which is identified by ¹HNMR and ¹³CNMR spec-
20 tral analyses.

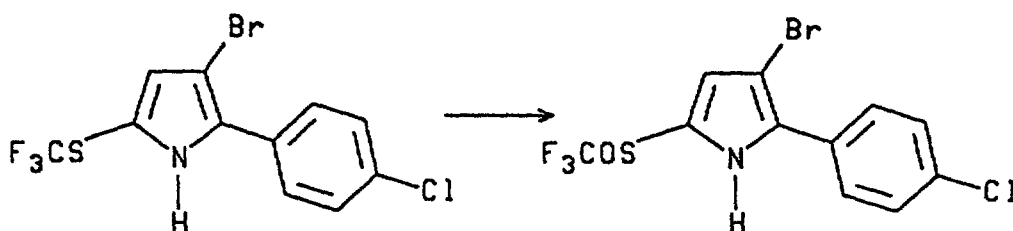
Following the above procedure, but using the
appropriately substituted 2-(p-chlorophenyl)-5-(sub-
stituted methyl)thio]pyrrole and two equivalents of
bromine yields 3,4-dibromo-2-(p-chlorophenyl)-5-[(tri-
25 fluoromethyl)thio]pyrrole, mp 105°-107°C and 3,4-di-
bromo-2-(p-chlorophenyl)-5-[(difluoromethyl)thio]-
pyrrole, mp 82°-92°C.

30

35

EXAMPLE 17

Preparation of 3-Bromo-2-(p-chlorophenyl)-5-[(trifluoromethyl)sulfinyl]pyrrole



15

A solution of 3-bromo-2-(p-chlorophenyl)-5-[(trifluoromethyl)thio]pyrrole (0.65 g, 0.00182 mol) in chloroform is cooled with an ice-water bath, treated with a solution of 3-chloroperoxybenzoic acid (0.52 g, 60% pure, 0.00182 mol) in chloroform, stirred for two hours, treated with saturated sodium metabisulfite solution, diluted with methylene chloride, washed with saturated sodium hydrogen carbonate solution and brine, dried over anhydrous magnesium sulfate and concentrated

20

in vacuo to obtain a white solid. Flash chromatography of the solid using silica gel and a 1:10 ethyl acetate/hexanes solution gives the title product as a white solid (0.34 g, mp 177^o-179^oC) which is identified by ¹HNMR spectral analysis.

25

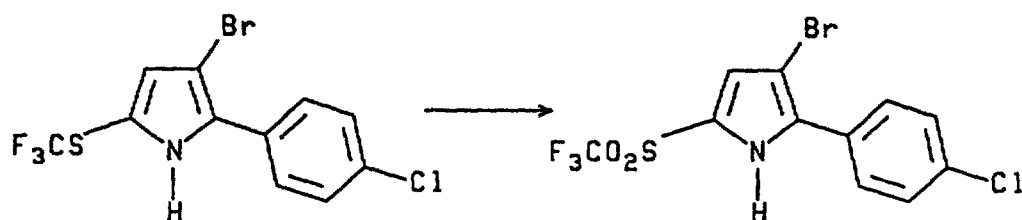
Following the above procedure, but using 3,4-dibromo-2-(p-chlorophenyl)-5-[(trifluoromethyl)thio]pyrrole for 3-bromo-2-(p-chlorophenyl)-5-[(trifluoromethyl)thio]pyrrole yields 3,4-dibromo-2-(p-chlorophenyl)-5-[(trifluoromethyl)sulfinyl]pyrrole, mp

30

173^o-176^oC.

EXAMPLE 18

Preparation of 3-Bromo-2-(p-chlorophenyl)-5-[(tri-
fluoromethyl)sulfonyl]pyrrole

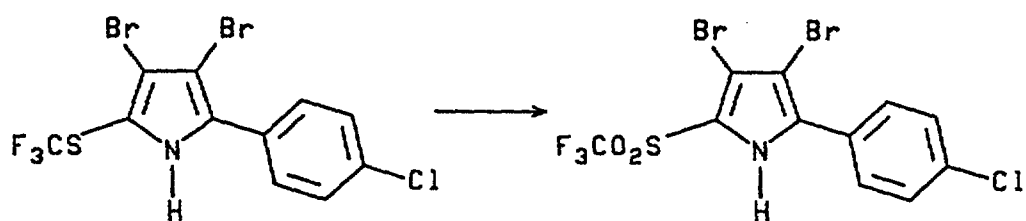


15 A solution of 3-bromo-2-(p-chlorophenyl)-5-
[(trifluoromethyl)thio]pyrrole (0.70 g, 0.00196 mol) in
chloroform is cooled with an ice-water bath, treated
with a solution of 3-chloroperoxybenzoic acid (1.3 g,
60% pure, 0.0045 mol) in chloroform, stirred for two
20 hours, warmed to room temperature, stirred overnight,
treated with saturated sodium metabisulfite solution,
diluted with methylene chloride, washed with saturated
sodium hydrogen carbonate solution and brine, dried
over anhydrous magnesium sulfate and concentrated in
25 vacuo to obtain a white solid. Flash chromatography of
the solid using silica gel and a 1:10 ethyl acetate/-
hexanes solution gives the title product as a white
solid (0.48 g, mp 155°-159°C) which is identified by
¹HNMR and ¹⁹FNMR spectral analyses.

30 Following the above procedure, but substi-
tuting 3,4-dibromo-2-(p-chlorophenyl)-5-[(difluoro-
methyl)thio]pyrrole for 3-bromo-2-(p-chlorophenyl)-5-
[(trifluoromethyl)sulfonyl]pyrrole yields 3,4-di-
bromo-2-(p-chlorophenyl)-5-[(difluoromethyl)sulfonyl]-
pyrrole, mp 194°-196°C (dec).

EXAMPLE 19

Preparation of 3,4-Dibromo-2-(p-chlorophenyl)-5-[(trifluoromethyl)sulfonyl]pyrrole



15 A solution of 3,4-dibromo-2-(p-chlorophenyl)-5-[(trifluoromethyl)thio]pyrrole (0.9 g, 0.00207 mol) in tetrahydrofuran is cooled with an ice-water bath, treated with a solution of monoperoxyphthalic acid, magnesium salt hexahydrate (1.4 g, 80% pure, 0.00227 mol) in tetrahydrofuran, stirred overnight at room temperature, treated with saturated sodium metabisulfite solution, diluted with ethyl acetate, washed with saturated sodium hydrogen carbonate solution and brine, dried over anhydrous magnesium sulfate and concentrated in vacuo to obtain a yellow residue. Flash chromatography of the residue using silica gel and a 1:10 ethyl acetate/hexanes solution gives the title product as a white solid (0.21 g, mp 165^o-168^oC) which is identified by ¹HNMR and ¹⁹FNMR spectral analyses.

20

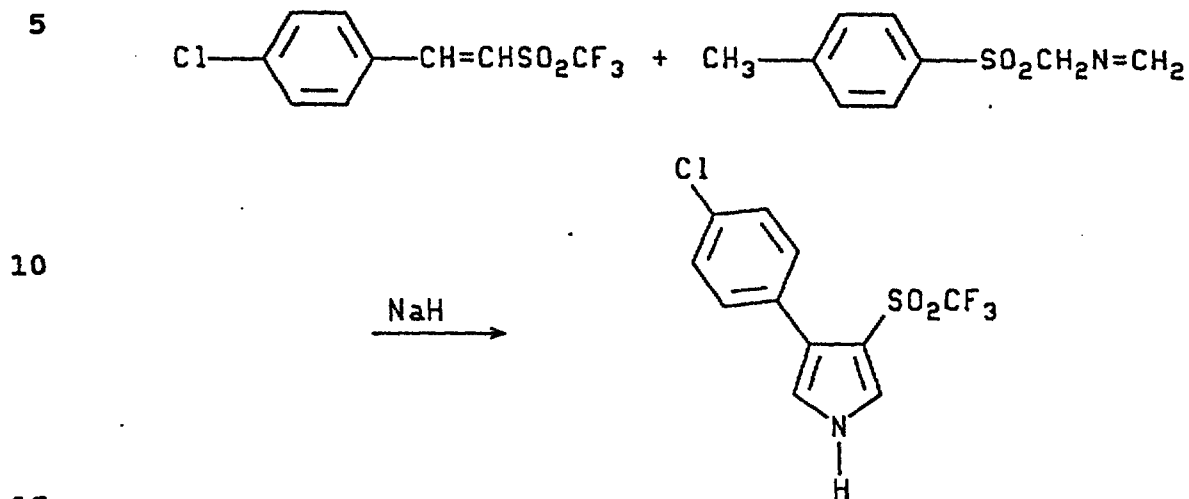
25

30

35

EXAMPLE 20

Preparation of 3-(p-Chlorophenyl)-4-[(trifluoromethyl)-sulfonyl]pyrrole



A mixture of sodium hydride (0.31 g, 60%, 0.0077 mol) and ether is treated dropwise with a solution of p-chlorostyryl trifluoromethylsulfone (1.73 g, 0.0064 mol), N-methylene-1-(p-tolylsulfonyl)-methanimine (1.25 g, 0.0064 mol), ether (20 mL) and dimethylsulfoxide (10 mL) with stirring under nitrogen. The reaction mixture is stirred for one hour, diluted with water and extracted with ether. The combined organic extracts are washed with brine, dried over anhydrous magnesium sulfate and concentrated in vacuo to obtain a yellow syrup. Flash chromatography of the syrup using silica gel and a 1:2 ethyl acetate/hexanes solution gives the title product as a white solid (1.4 g, mp 138^o-141^oC) which is identified by ¹HNMR, ¹⁹FNMR and ¹³CNMR spectral analyses.

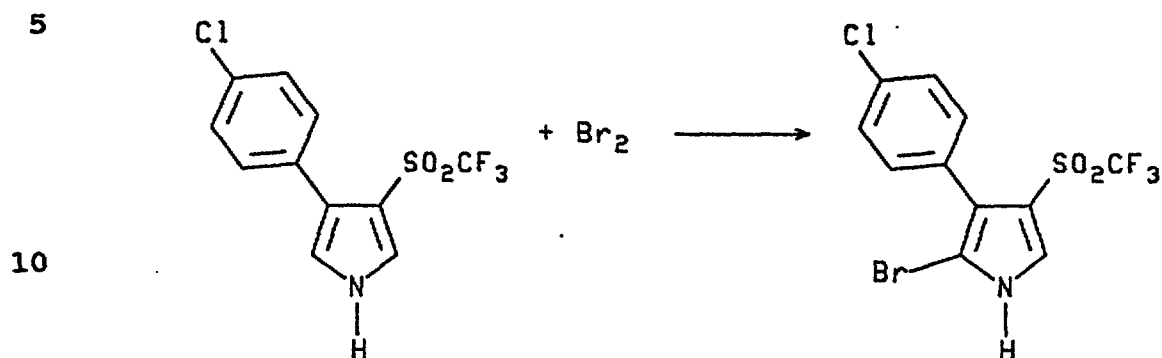
20

25

30

EXAMPLE 21

Preparation of 2-Bromo-3-(p-chlorophenyl)-4-[(tri
fluoromethyl)sulfonyl]pyrrole



15 A solution of 2-bromo-3-(p-chlorophenyl)-4-
[(trifluoromethyl)sulfonyl]pyrrole (0.5 g, 0.00161 mol)
in chloroform is cooled with an ice-water bath, treated
with a solution of bromine (0.258 g, 0.00161 mol) in
chloroform, stirred for several hours, diluted with
methylene chloride, washed with water and brine, dried
over anhydrous magnesium sulfate and concentrated in
20 vacuo to obtain a white solid. Flash chromatography of
the solid using silica gel and a 1:3 ethyl acetate/-
hexanes solution gives the title product as a white
solid (0.54 g, mp 163^o-165^oC) which is identified by
¹HNMR and ¹³CNMR spectral analyses.

25 Following the above procedure, but using two
equivalents of bromine yields 2,5-dibromo-3-(p-chloro-
phenyl)-4-[(trifluoromethyl)sulfonyl]pyrrole, mp
224^o-226^oC.

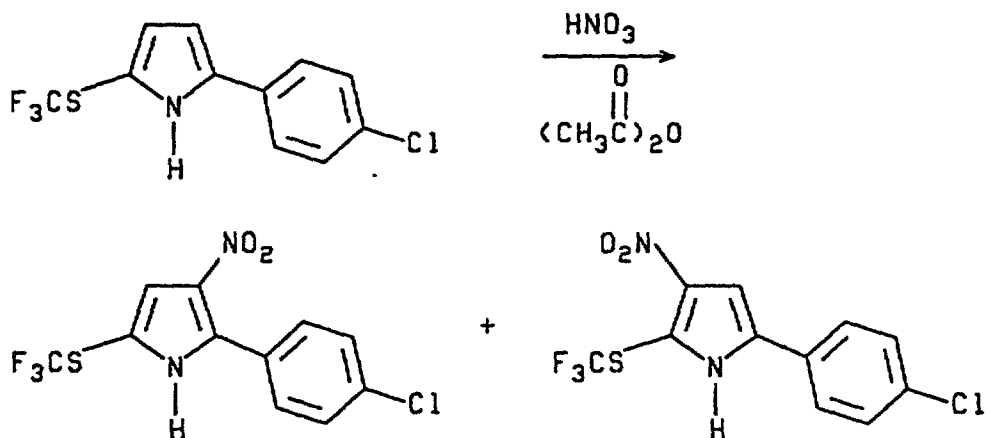
30

35

EXAMPLE 22

Preparation of 2-(p-chlorophenyl)-3-nitro-5-[(tri-fluoromethyl)thio]pyrrole and 5-(p-chlorophenyl)-3-nitro-2-[(trifluoromethyl)thio]pyrrole

5



10

15

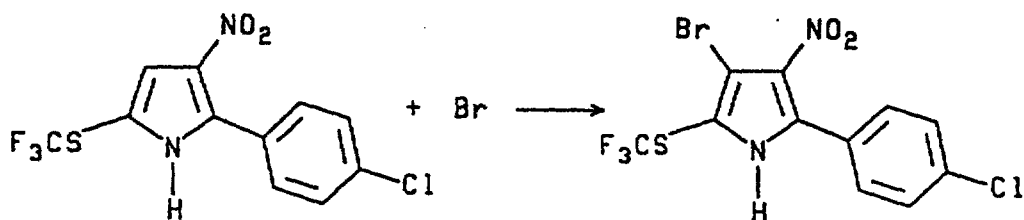
A solution of 2-(p-chlorophenyl)-5-[(tri-fluoromethyl)thio]pyrrole (1.0 g, 0.0036 mol) in acetic acid is cooled with an ice bath, treated with nitric acid (0.24 g, 0.00378 mol), stirred for two hours, poured into ice-water and stirred for one hour. The aqueous solution is filtered and the filter cake is washed with water and dried in a vacuum dessicator to obtain a tan solid. Flash chromatography of the solid using silica gel and a 1:10 ethyl acetate/hexanes solution gives 2-(p-chlorophenyl)-3-nitro-5-[(tri-fluoromethyl)thio]pyrrole as a yellow solid (0.45 g, mp 143^o-145^oC) and 5-(p-chlorophenyl)-3-nitro-2-[(tri-fluoromethyl)thio]pyrrole as a yellow solid (0.17 g, mp 185^o-193^oC). Both products are identified by ¹HNMR, ¹⁹FNMR and ¹³CNMR spectral analyses.

30

35

EXAMPLE 23

Preparation of 3-Bromo-5-(p-chlorophenyl)-4-nitro-2-[(trifluoromethyl)thio]pyrrole

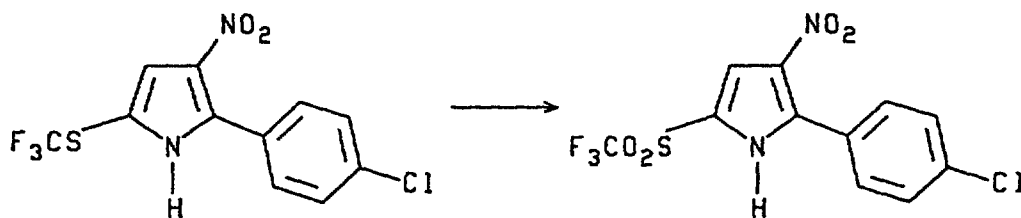


15 A solution of 2-(p-chlorophenyl)-3-nitro-5-[(trifluoromethyl)thio]pyrrole (0.35 g, 0.0011 mol) and sodium acetate (0.11 g, 0.0013 mol) in acetic acid is treated with a solution of bromine (0.21 g, 0.0013 mol) in acetic acid, stirred for one hour, poured into water and extracted with ethyl acetate. The combined organic

20 extracts are washed with water and brine, dried over anhydrous magnesium sulfate and concentrated in vacuo to obtain a residue. Flash chromatography of the residue using silica gel and a 1:9 ethyl acetate/-hexanes solution gives the title product as a yellow solid (0.25 g, mp 160°-165°C) which is identified by ¹HNMR, ¹⁹FNMR and ¹³CNMR spectral analyses.

EXAMPLE 24

Preparation of 2-(p-Chlorophenyl)-3-nitro-5-[(trifluoromethyl)sulfonyl]pyrrole

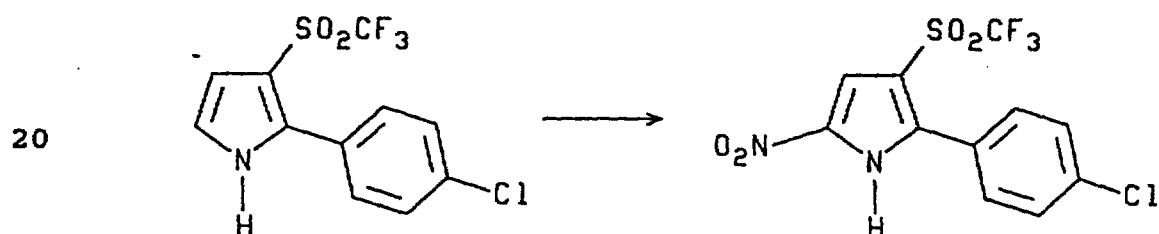


A solution of 2-(p-chlorophenyl)-3-nitro-5-[(trifluoromethyl)thio]pyrrole (0.24 g, 0.000744 mol) in chloroform is cooled with an ice bath, treated with

3-chloroperoxybenzoic acid (0.49 g, 60%, 0.00171 mol) and stirred for one hour. The cooling bath is removed and the reaction mixture is stirred for one hour, treated with saturated sodium bisulfite solution,
5 diluted with methylene chloride, washed with saturated sodium hydrogen carbonate solution and brine, dried over anhydrous magnesium sulfate and concentrated in vacuo to obtain a yellow syrup. Flash chromatography of the syrup using silica gel and 1:3 ethyl acetate/-
10 hexanes solution gives the title product as a yellow solid (0.26 g, mp 97°-99°C) which is identified by ¹HNMR and ¹⁹FNMR spectral analyses.

EXAMPLE 25

15 Preparation of 2-(p-Chlorophenyl)-5-nitro-3-[(tri-fluoromethyl)sulfonyl]pyrrole

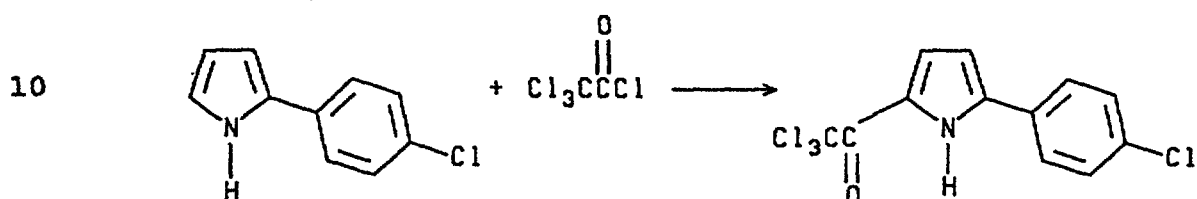


A solution of 2-(p-chlorophenyl)-3-[(tri-fluoromethyl)sulfonyl]pyrrole (1.0 g, 0.00323 mol) in
25 acetic anhydride is cooled with an ice bath, treated with nitric acid (0.15 mL, 0.00329 mol), warmed to room temperature, stirred for 20 hours and poured into water. The mixture is decanted and the insolubles are dissolved in ethyl acetate. The ethyl acetate solution
30 is washed with brine, dried over anhydrous magnesium sulfate and concentrated in vacuo to obtain an amber residue. Flash chromatography of the residue using silica gel and a 1:1 ethyl acetate/hexanes solution gives the title product as a tan solid (0.43 g, mp
35

174°-180°C) which is identified by ¹HNMR spectral analysis.

EXAMPLE 26

5 Preparation of 5-(p-Chlorophenyl)pyrrol-5-yl trichloro-
methyl ketone



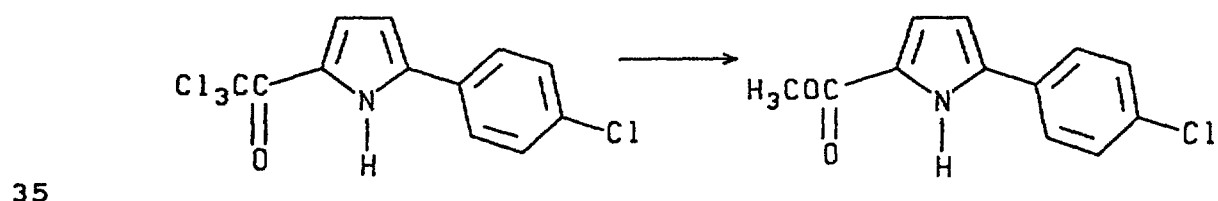
15 A solution of trichloroacetyl chloride (11.26 g, 0.0619 mol) in ether is treated with a solution of 2-(p-chlorophenyl)pyrrole (10.0 g, 0.0503 mol) in ether, stirred for four hours at room temperature, treated with saturated potassium carbonate solution and diluted with ethyl acetate. The organic phase is separated, washed with brine, dried over

20 anhydrous magnesium sulfate and concentrated in vacuo to obtain a yellow solid. The solid is recrystallized from 2-propanol to give the title product as a yellow solid (12.63 g, mp 166°-168°C) which is identified by

25 ¹HNMR spectral analysis.

EXAMPLE 27

30 Preparation of Methyl 5-(p-chlorophenyl)pyrrole-2-
carboxylate



A solution of sodium methoxide (12.73 mL of 4.38 M solution in methanol, 0.0556 mol) in methanol is cooled with an ice bath, treated with 5-(p-chlorophenyl)pyrrol-5-yl trichloromethyl ketone

5 (6.0 g, 0.0186 mol), stirred for two hours, diluted with water and filtered to obtain a solid. The solid is washed with water and dried overnight in a vacuum dessicator to give the title product as a tan solid (4.23 g, mp 177^o-179^oC) which is identified by ¹HNMR
10 spectral analysis.

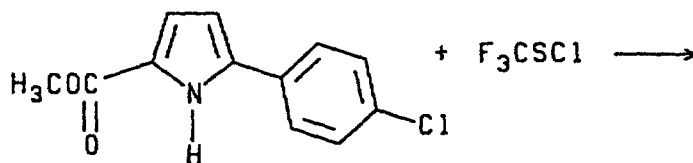
Following the above procedure, but substituting sodium ethoxide and ethanol for sodium methoxide and methanol yields ethyl 5-(p-chlorophenyl)pyrrole-2-carboxylate, mp 148^o-150.5^oC.

15

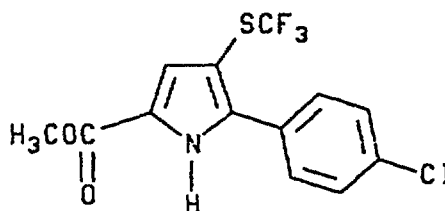
EXAMPLE 28

Preparation of Methyl 5-(p-chlorophenyl)-4-[(trifluoromethyl)thio]pyrrole-2-carboxylate

20



25



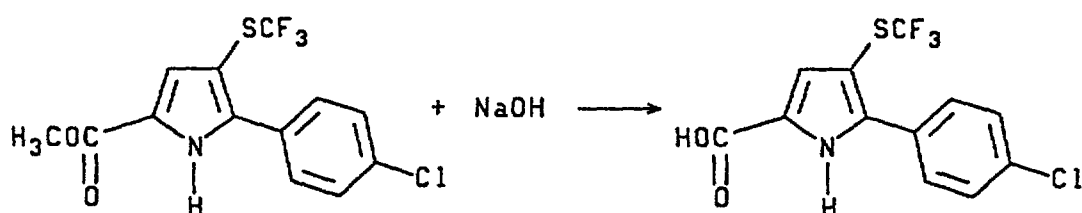
30

Trifluoromethanesulfonic acid (0.27 g, 0.001795 mol) is added to a solution of methyl 5-(p-chlorophenyl)pyrrole-2-carboxylate (4.23 g, 0.01795 mol) in methylene chloride (70 mL) at -30^oC. This mixture is treated with trifluoromethylsulfenyl chloride (4.0 g, 0.0293 mol), stirred for 30 minutes at
35 -15^oC, warmed to room temperature with stirring for

three hours, diluted with methylene chloride, washed with saturated sodium hydrogen carbonate solution and brine, dried over anhydrous magnesium sulfate and concentrated in vacuo to obtain the title product as an off-white solid (5.44 g, mp 133°-137°C) which is identified by ¹HNMR spectral analysis.

EXAMPLE 29

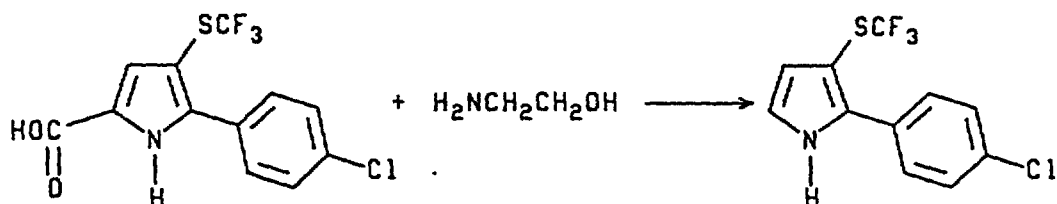
Preparation of 5-(p-Chlorophenyl)-4-[(trifluoromethyl)-thio]pyrrole-2-carboxylic acid



A mixture of methyl 5-(p-chlorophenyl)-4-[(trifluoromethyl)thio]pyrrole-2-carboxylate (4.89 g, 0.0146 mol) and sodium hydroxide (1.75 g, 0.0437 mol) in a 2:1 methanol/water solution (150 mL) is warmed to 60°C, stirred for three hours, cooled to room temperature with stirring overnight and concentrated in vacuo to remove most of the methanol. The resulting aqueous solution is treated with 10% hydrochloric acid and a white precipitate forms. Ethyl acetate is added and the organic phase is separated, washed with brine, dried over anhydrous magnesium sulfate and concentrated in vacuo to give the title product as an off-white solid (4.98 g, mp 176°-178°C) which is identified by ¹HNMR spectral analysis.

EXAMPLE 30

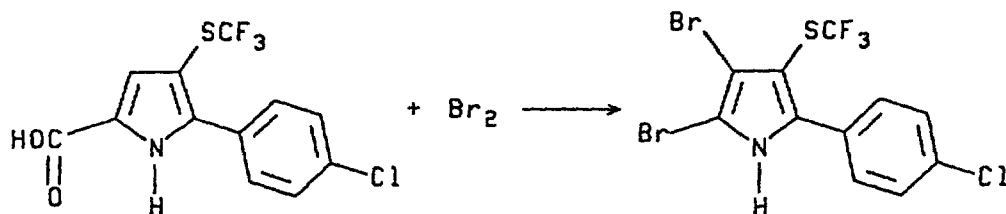
Preparation of 2-(p-Chlorophenyl)-3-[(trifluoromethyl)-thio]pyrrole



A mixture of 5-(p-chlorophenyl)-4-[(tri-
fluoromethyl)thio]pyrrole-2-carboxylic acid
(0.5 g, 0.00155 mol) in ethanolamine (1.5 mL) is
15 stirred at 160°C for five hours, cooled to room temper-
ature overnight with stirring, poured into water and
extracted with ether. The combined organic extracts
are washed with brine, dried over anhydrous magnesium
sulfate and concentrated in vacuo to obtain a yellow
20 syrup. Flash chromatography of the syrup using silica
gel and a 1:4 ethyl acetate/hexanes solution gives the
title product as an off-white solid (0.11 g, mp 59°-
64°C) which is identified by ¹HNMR and ¹⁹FNMR spectral
analyses.

EXAMPLE 31

Preparation of 2,3-Dibromo-5-(p-chlorophenyl)-4-[(tri-
fluoromethyl)thio]pyrrole

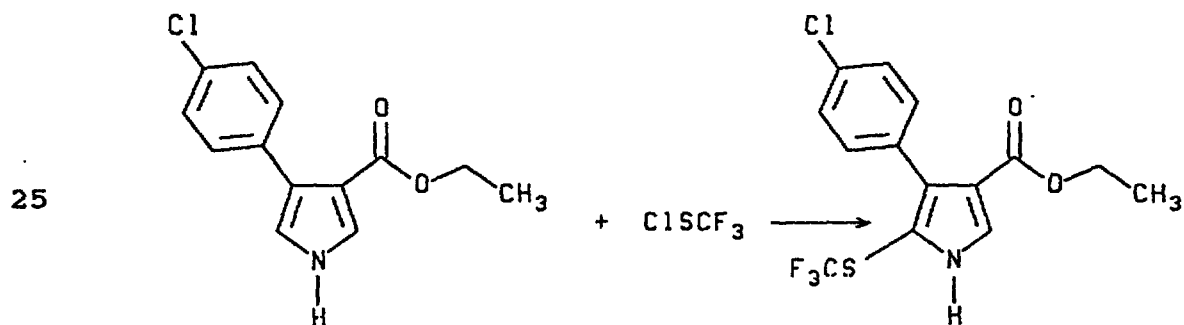


5 A solution of 5-(p-chlorophenyl)-4-[(tri-
fluoromethyl)thio]pyrrole-2-carboxylic acid (0.75 g,
0.00233 mol) and sodium acetate (0.84 g, 0.0103 mol) in
acetic acid (15 mL) is treated dropwise with a solution
of bromine (0.82 g, 0.00513 mol) in acetic acid
(7.5 mL), stirred for two hours, diluted with water and
extracted with ether. The combined organic extracts
are washed with water, saturated metabisulfite solu-
tion, saturated sodium hydrogen carbonate solution and
10 brine, dried over anhydrous magnesium sulfate and
concentrated in vacuo to obtain a yellow syrup. Flash
chromatography of the syrup using silica gel and a 1:10
ethyl acetate/hexanes solution gives the title product
as a tan solid (0.52 g, mp 107^o-113^oC) which is iden-
15 tified by ¹HNMR, ¹³CNMR and ¹⁹FNMR spectral analyses.

EXAMPLE 32

Preparation of Ethyl 4-(p-chlorophenyl)-5-[(trifluoro- methyl)thio]pyrrole-3-carboxylate

20

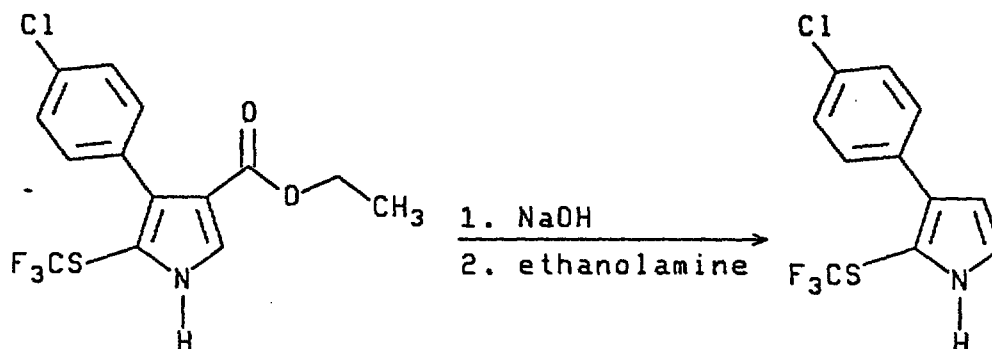


30 A solution of ethyl 4-(p-chlorophenyl)-
pyrrole-3-carboxylate (9.0 g, 0.036 mol) in methylene
chloride (180 mL) is treated with trifluoromethyl-
sulfenyl chloride (4.9 g, 0.036 mol) with stirring for
45 minutes at -30^oC. The reaction mixture is warmed to
room temperature and stirred for several hours. Since
35 a TLC shows some starting material present, the

reaction mixture is cooled to -30°C , treated with additional trifluoromethylsulfenyl chloride (1.3 g, 0.0095 mol), warmed to room temperature overnight with stirring, washed with water, saturated sodium hydrogen carbonate solution and brine, dried over anhydrous magnesium sulfate and concentrated in vacuo to give the title product as an off-white solid (12.0 g, mp 161.5°C - 164.0°C) which is identified by ^1H NMR, ^{19}F NMR and ^{13}C NMR spectral analyses.

EXAMPLE 33

Preparation of 3-(p-Chlorophenyl)-2-[(trifluoromethyl)-thio]pyrrole

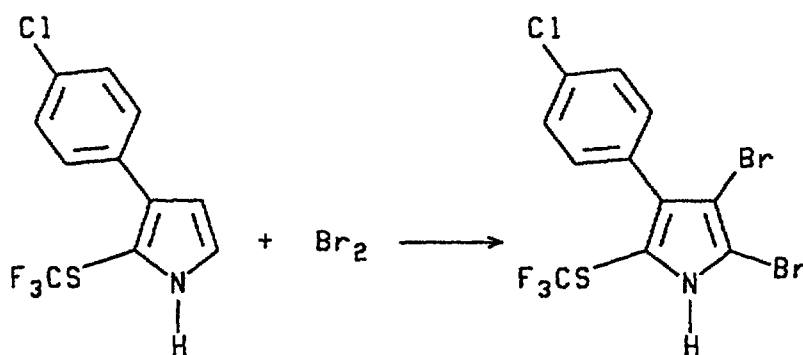


A solution of ethyl 4-(p-chlorophenyl)-5-[(trifluoromethyl)thio]pyrrole-3-carboxylate (8.0 g, 0.023 mol) in 10% aqueous sodium hydroxide solution is refluxed for several hours, stirred at room temperature overnight, poured into ice-water, treated with concentrated hydrochloric acid and extracted with ether. The combined organic extracts are washed with water and brine, dried over anhydrous magnesium sulfate and concentrated in vacuo to obtain a brown semi-solid. A solution of the semi-solid (6.9 g) in ethanolamine is heated at 110°C for several hours, poured into ice-water and extracted with chloroform. The combined organic extracts are washed with water and brine, dried

over anhydrous magnesium sulfate and concentrated in vacuo to give a brown oil. The oil is dissolved in methylene chloride, filtered through a bed of silica gel and the filtrate is concentrated in vacuo to obtain the title product as a grey semi-solid (4.8 g, mp 44°-46°C) which is identified by ¹HNMR spectral analysis.

EXAMPLE 34

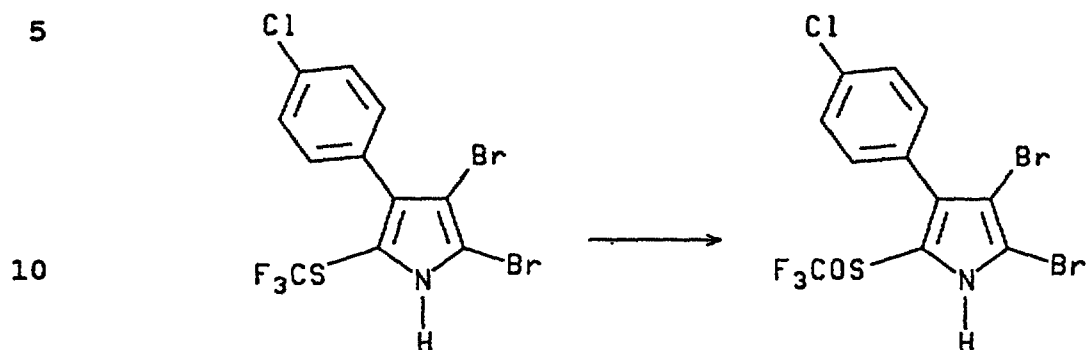
Preparation of 2,3-Dibromo-4-(p-chlorophenyl)-5-[(trifluoromethyl)thio]pyrrole



A solution of 3-(p-chlorophenyl)-2-[(trifluoromethyl)thio]pyrrole (3.0 g, 0.0108 mol) in methylene chloride (15 mL) is treated with bromine (4.0 g, 0.025 mol, 1.3 mL), stirred for one hour, washed with water and brine, dried over anhydrous magnesium sulfate and concentrated in vacuo to give the title product as a purple semi-solid (4.2 g) which is identified by ¹HNMR and ¹³CNMR spectral analyses.

EXAMPLE 35

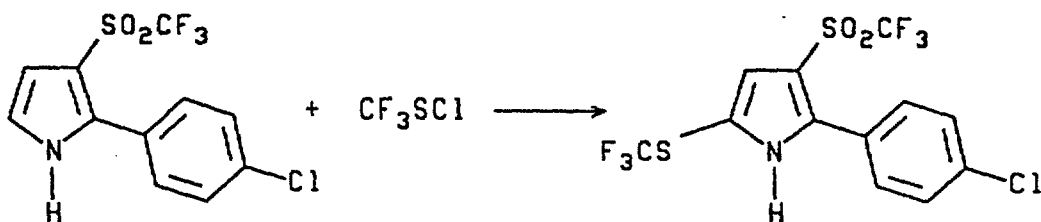
Preparation of 2,3-Dibromo-4-(p-chlorophenyl)-5-[(tri-fluoromethyl)sulfinyl]pyrrole



A solution of 2,3-dibromo-4-(p-chlorophenyl)-5-[(trifluoromethyl)thio]pyrrole (1.0 g, 0.0023 mol) in chloroform (10 mL) is treated with 3-chloroperoxybenzoic acid (0.4 g, 60%, 0.0023 mol) with stirring at 0°C, warmed to room temperature with stirring for two hours, washed with saturated sodium metabisulfite solution, saturated sodium hydrogen carbonate solution, water and brine, dried over anhydrous magnesium sulfate and concentrated in vacuo to obtain a yellow syrup. Flash chromatography of the syrup using silica gel and a 1:4 ethyl acetate/hexanes solution gives the title product as a yellow solid (0.4 g, mp 165.5°-167.5°C) which is identified by ¹HNMR, ¹⁹FNMR and ¹³CNMR spectral analyses.

EXAMPLE 36

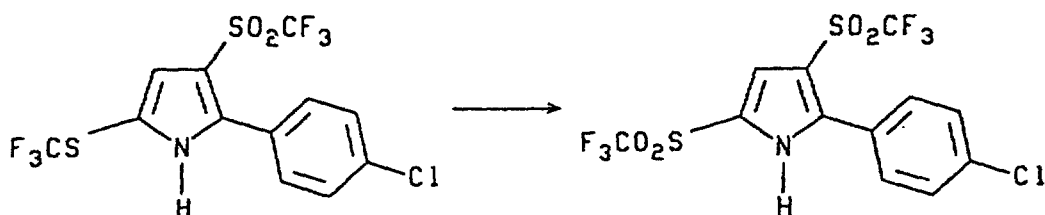
Preparation of 2-(p-chlorophenyl)-3-[(trifluoromethyl)sulfonyl]-5-[(trifluoromethyl)thio]pyrrole



A solution of 2-(p-chlorophenyl)-3-[(trifluoromethyl)sulfonyl]pyrrole (2.47 g, 0.0080 mol), trifluoromethylsulfonyl chloride (2.18 g, 0.016 mol), trifluoromethanesulfonic acid (0.12 g, 0.0008 mol) and 1,2-dichloroethane (15 mL) is placed in a pressure tube, heated at 70°C for five days, diluted with methylene chloride, washed with saturated sodium hydrogen carbonate solution and brine, dried over anhydrous magnesium sulfate and concentrated in vacuo to obtain an amber syrup. Flash chromatography of the syrup using silica gel and a 1:5 ethyl acetate/hexanes solution gives the title product as an off-white solid (2.36 g, mp 118°-122°C) which is identified by ¹HNMR and ¹³CNMR spectral analyses.

EXAMPLE 37

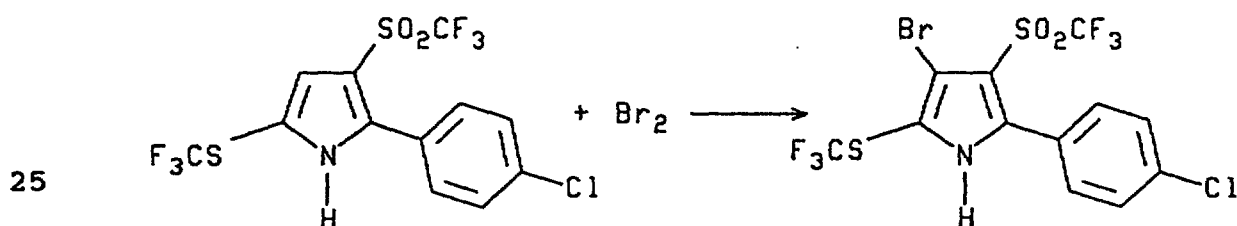
Preparation of 3,5-Bis[(trifluoromethyl)sulfonyl]-2-(p-chlorophenyl)pyrrole



A solution of 2-(p-chlorophenyl)-3-[(tri-
fluoromethyl)sulfonyl]-5-[(trifluoromethyl)thio]pyrrole
(0.5 g, 0.00122 mol) in chloroform (20 mL) is cooled
with an ice bath, treated with 3-chloroperoxybenzoic
5 acid (0.81 g, 60% pure, 0.00281 mol), stirred for four
hours, warmed to room temperature and stirred over-
night. The reaction mixture is diluted with methylene
chloride, washed sequentially with saturated sodium
hydrogen carbonate solution and brine, dried over
10 anhydrous magnesium sulfate and concentrated in vacuo
to obtain a solid. Flash chromatography of the solid
using silica gel and a 2:1 ethyl acetate/hexanes
solution gives a solid which is recrystallized from
carbon tetrachloride to obtain the title product as a
15 white solid (0.23 g, mp 142^o-144^oC) which is identified
by ¹HNMR spectral analysis.

EXAMPLE 38

Preparation of 3-Bromo-5-(p-chlorophenyl)-4-[(tri-
20 fluoromethyl)sulfonyl]-2-[(trifluoromethyl)thio]pyrrole

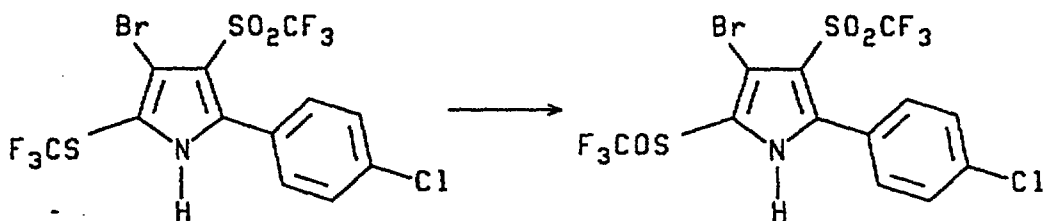


A solution of 2-(p-chlorophenyl)-3-[(tri-
fluoromethyl)sulfonyl]-5-[(trifluoromethyl)thio]pyrrole
(0.5 g, 0.00122 mol) in chloroform (10 mL) is cooled
30 with an ice bath, treated with a solution of bromine
(0.21 g, 0.00134 mol) in chloroform (5 mL), stirred for
two hours, warmed to room temperature, treated with two
drops of additional bromine and stirred for one hour.
The reaction mixture is diluted with methylene chlo-
35 ride, washed with water, saturated sodium hydrogen

carbonate solution, saturated sodium metabisulfite solution and brine, dried over anhydrous magnesium sulfate and concentrated in vacuo to obtain a syrup. Flash chromatography of the syrup using silica gel and a 1:5 ethyl acetate/hexanes solution gives the title product as a white solid (0.25 g, mp 122^o-125^oC) which is identified by ¹HNMR and ¹³CNMR spectral analyses.

EXAMPLE 39

Preparation of 3-Bromo-5-(p-chlorophenyl)-2-[(trifluoromethyl)sulfinyl]-4-[(trifluoromethyl)sulfonyl]-pyrrole



A solution of 3-bromo-5-(p-chlorophenyl)-4-[(trifluoromethyl)sulfonyl]-2-[(trifluoromethyl)thio]pyrrole (0.4 g, 0.00082 mol) in chloroform (5 mL) is cooled with an ice bath, treated with a solution of 3-chloroperoxybenzoic acid (0.24 g, 60%, 0.00082 mol) in chloroform (10 mL), stirred for two hours, warmed to room temperature and stirred overnight. The reaction mixture is treated with saturated sodium metabisulfite solution, diluted with methylene chloride, washed with saturated sodium hydrogen carbonate solution and brine, dried over anhydrous magnesium sulfate and concentrated in vacuo to obtain a residue. The residue is placed on a prep plate and eluted with a 1:2 ethyl acetate/-hexanes solution to give the title product as a white solid (0.25 g, mp 120^o-170^oC) which is identified by ¹HNMR spectral analysis.

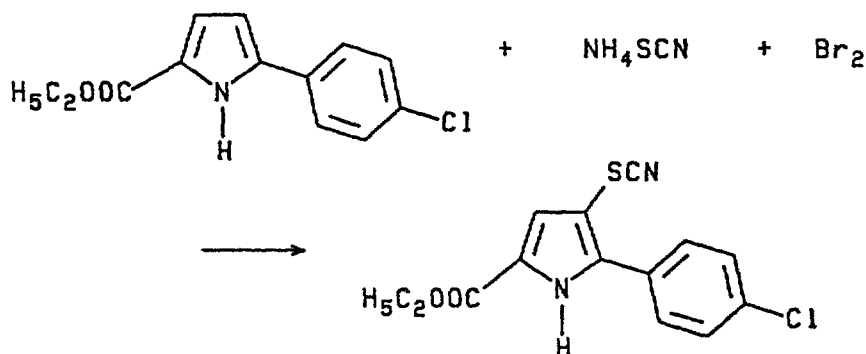
Following the above procedure, but using at least two equivalents of 3-chloroperoxybenzoic acid yields 2,4-bis[(trifluoromethyl)sulfonyl]-3-bromo-5-(p-chlorophenyl)pyrrole, mp 115°-135°C.

5

EXAMPLE 40

Preparation of Ethyl 5-(p-chlorophenyl)-4-thiocyanato-
pyrrole-2-carboxylate

10



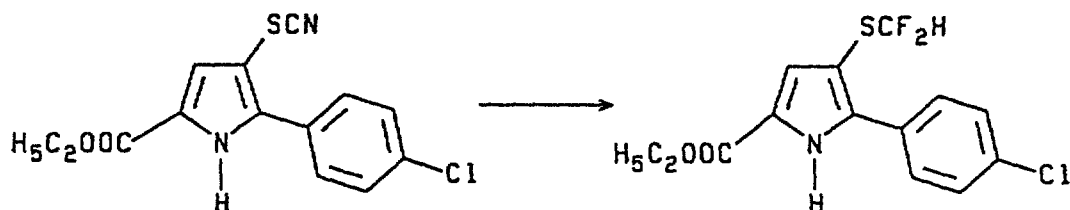
15

A solution of ethyl 5-(p-chlorophenyl)-pyrrole-2-carboxylate (0.95 g, 3.8 mmol) in acetic acid (20 mL) is treated with ammonium thiocyanate (1.75 g, 22.8 mmol), stirred at room temperature for five minutes, cooled to 15°C, treated with a solution of bromine (0.91 g, 5.7 mmol) in acetic acid (10 mL) and stirred at room temperature for several hours. The reaction mixture is filtered to remove solids and the filtrate is poured into water and stirred. The aqueous mixture is filtered to obtain an off-white solid. Flash chromatography of the solid using a 1:10 ethyl acetate/hexanes solution gives the title product as a white solid (0.99 g, mp 138°-141°C) which is identified by ^1H NMR and ^{13}C NMR spectral analyses.

35

EXAMPLE 41

Preparation of Ethyl 5-(p-chlorophenyl)-4-[(difluoromethyl)thio]pyrrole-2-carboxylate

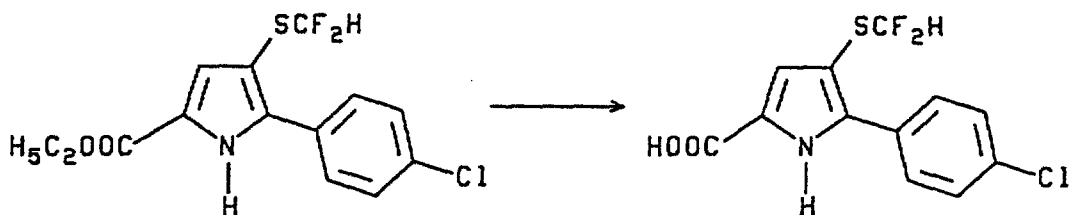


A solution of ethyl 5-(p-chlorophenyl)-4-thiocyanatopyrrole-2-carboxylate (76.7 mg, 0.25 mmol) in 2-propanol is treated with sodium borohydride (11.0 mg, 0.29 mmol) under nitrogen, heated to 70°C for ten minutes, cooled to room temperature, treated with a solution of potassium hydroxide (16.8 mg, 0.30 mmol) in 2-propanol, treated with tributylphosphine (81.2 mg, 0.4 mmol), heated to 65°C-70°C and treated with excess chlorodifluoromethane for one hour. Additional tributylphosphine (81.2 mg, 0.4 mmol) is added to the reaction mixture and the addition of chlorodifluoromethane is continued for 30 minutes. The mixture is then poured into brine and extracted with ethyl acetate. The combined organic extracts are washed with water, dried over anhydrous sodium sulfate and concentrated in vacuo to obtain a liquid. Flash chromatography of the liquid using silica gel and a 1:10 ethyl acetate/hexanes solution gives the title product as a white solid (42.6 mg, mp 113-117°C) which is identified by ¹HNMR and ¹³CNMR spectral analyses.

Following the above procedure, but substituting tetrafluoroethylene for chlorodifluoromethane yields ethyl 5-(p-chlorophenyl)-4-[(1,1,2,2-tetrafluoroethyl)thio]pyrrole-2-carboxylate.

EXAMPLE 42

Preparation of 5-(p-Chlorophenyl)-4-[(difluoromethyl)-thio]pyrrole-2-carboxylic acid



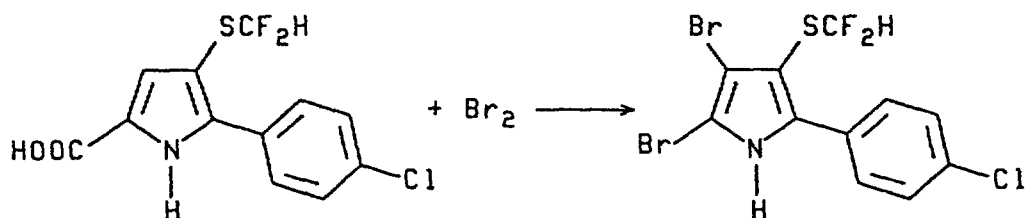
A solution of ethyl 5-(p-chlorophenyl)-4-[(difluoromethyl)thio]pyrrole-2-carboxylate (166 mg, 0.5 mmol) in ethanol is treated under nitrogen with a solution of sodium hydroxide (100 mg, 2.5 mmol) in water. The reaction mixture is refluxed for three hours, poured into ice-water, treated with hydrochloric acid and extracted with ethyl acetate. The combined organic extracts are washed with water and brine, dried over anhydrous sodium sulfate and concentrated in vacuo to obtain the title product as an orange solid (158 mg, mp 165°C (dec)) which is identified by ¹HNMR and ¹³CNMR spectral analyses.

15

20

EXAMPLE 43

Preparation of 2,3-Dibromo-5-(p-chlorophenyl)-4-[(difluoromethyl)thio]pyrrole



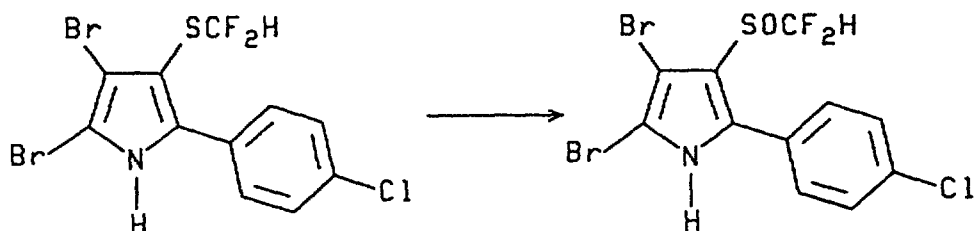
A solution of 5-(p-chlorophenyl)-4-[(difluoromethyl)thio]pyrrole-2-carboxylic acid (5.39 g, 0.0178 mol) and sodium acetate (6.4 g, 0.0781 mol) in

35

acetic acid is treated with a solution of bromine (6.24 g, 0.039 mol) in acetic acid under nitrogen. The reaction mixture is stirred for three hours at room temperature, poured into ice-water and extracted with ethyl acetate. The combined organic extracts are washed with water, saturated sodium hydrogen carbonate solution and brine, dried over anhydrous sodium sulfate and concentrated in vacuo to obtain a red gum. A mixture of the gum, ethyl acetate and silica gel is evaporated to dryness and placed on a column packed with silica gel. The column is eluted with a 1:10 ethyl acetate/hexanes solution to obtain a gum. The gum is dissolved in ethyl acetate, treated with carbon black, filtered through celite and concentrated in vacuo to obtain an orange gum. The orange gum is dissolved in an ether/pentane solution, cooled to 0°C and filtered to remove solids. After the filtrate is concentrated in vacuo, the residue is dissolved in acetone, treated with carbon black, filtered through celite and concentrated in vacuo to give the title product as a red gum (4.33 g) which is identified by ¹HNMR spectral analysis.

EXAMPLE 44

Preparation of 2,3-Dibromo-5-(p-chlorophenyl)-4-[(difluoromethyl)sulfinyl]pyrrole

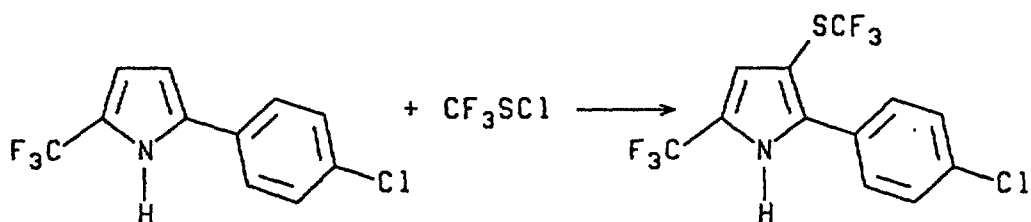


A solution of 2,3-dibromo-5-(p-chlorophenyl)-4-[(difluoromethyl)thio]pyrrole (125 mg,

0.030 mmol) in chloroform is treated with 3-chloro-
peroxybenzoic acid (86 mg, 60%, 0.30 mmol) at 0°C. The
reaction mixture is stirred for one hour at 0°C, warmed
to room temperature, stirred overnight, poured into
5 saturated sodium metabisulfite solution and diluted
with a methylene chloride/water mixture. The organic
phase is separated, washed with saturated sodium
hydrogen carbonate solution, dried over anhydrous
sodium sulfate and concentrated in vacuo to obtain a
10 residue. Flash chromatography of the residue using
silica gel and a 1:10 ethyl acetate/hexanes solution
gives the title product as a yellow solid (68 mg, mp
180°C (dec)) which is identified by ¹HNMR and ¹³CNMR
spectral analyses.

EXAMPLE 45

Preparation of 2-(p-Chlorophenyl)-5-(trifluoromethyl)-
3-[(trifluoromethyl)thio]pyrrole

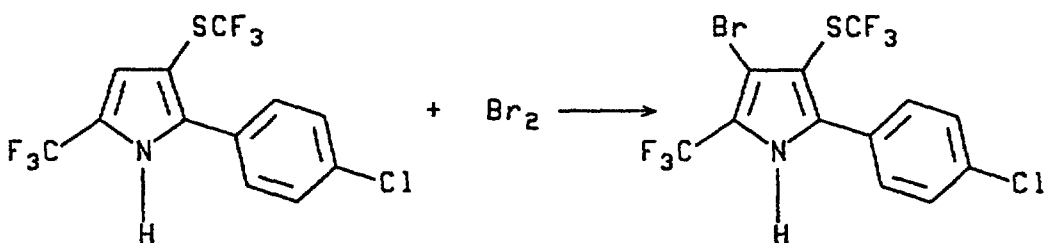


A solution of 2-(p-chlorophenyl)-5-(tri-
fluoromethyl)pyrrole (11.2 g, 45.7 mmol) in methylene
chloride is treated with an excess of trifluoromethyl-
sulfenyl chloride, stirred overnight at room tempera-
30 ture, treated with trifluoromethanesulfonic acid (40
drops) and additional trifluoromethylsulfenyl chloride,
stirred for 30 minutes and diluted with an ether/water
mixture. The organic phase is separated, washed with
water, dried over anhydrous magnesium sulfate and
35 concentrated in vacuo to obtain a purple oil. Flash

chromatography of the oil using silica gel and a 1:9 ethyl acetate/hexanes solution gives a blue oil which is crystallized from petroleum ether to obtain the title product as a purple solid (mp 53.0°-55.0°C) which is identified by ¹HNMR and ¹³CNMR spectral analyses.

EXAMPLE 46

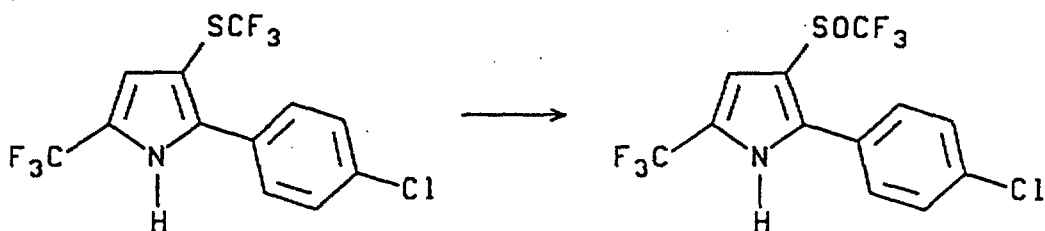
Preparation of 3-Bromo-5-(p-chlorophenyl)-2-(trifluoromethyl)-4-[(trifluoromethyl)thio]pyrrole



A solution of 2-(p-chlorophenyl)-5-(trifluoromethyl)-3-[(trifluoromethyl)thio]pyrrole (1.03 g, 3.0 mmol) and sodium acetate (0.3 g, 3.6 mmol) in acetic acid is treated with bromine (0.58 g, 3.6 mmol), stirred for 30 minutes at room temperature and diluted with an ethyl acetate/water mixture. The organic phase is separated, washed with water, dried over anhydrous magnesium sulfate and concentrated in vacuo to obtain a semi-solid. Chromatography of the semi-solid using silica gel and hexanes gives the title product as a white solid (mp 87.0°-88.5°C) which is identified by ¹HNMR, ¹⁹FNMR and ¹³CNMR spectral analyses.

EXAMPLE 47

Preparation of 2-(p-Chlorophenyl)-5-(trifluoromethyl)-3-[(trifluoromethyl)sulfinyl]pyrrole

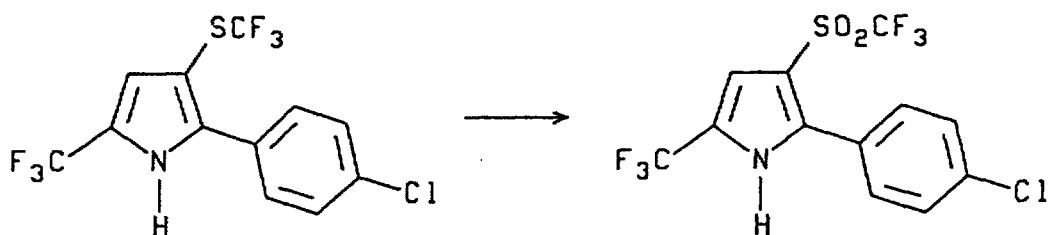


15 A solution of 2-(p-chlorophenyl)-5-(trifluoromethyl)-3-[(trifluoromethyl)thio]pyrrole (5.5 g, 15.9 mmol) in chloroform is cooled to 0°C, treated with 3-chloroperoxybenzoic acid (5.49 g, 60%, 19.1 mmol), stirred for several hours and filtered to remove solids. The solids are dissolved into ether and the organic solution is washed with water and saturated sodium hydrogen carbonate solution, dried over anhydrous magnesium sulfate and concentrated in vacuo to obtain a solid. Recrystallization of the solid from ether gives the title product as a white solid (mp 198°-200°C) which is identified by ¹HNMR, ¹⁹FNMR and ¹³CNMR spectral analyses.

20

EXAMPLE 48

25 Preparation of 2-(p-Chlorophenyl)-5-(trifluoromethyl)-3-[(trifluoromethyl)sulfonyl]pyrrole

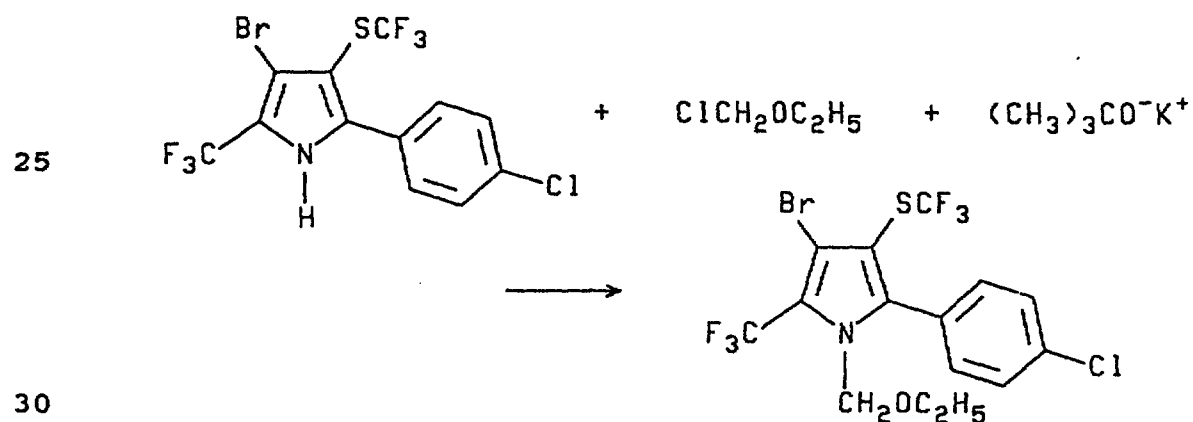


A solution of 2-(p-chlorophenyl)-5-(trifluoromethyl)-3-[(trifluoromethyl)thio]pyrrole (1.5 g, 4.3 mmol) in acetic acid is treated with hydrogen

peroxide (1.5 mL, 30%, 13 mmol), stirred at 95°C for several hours, treated with additional hydrogen peroxide (1 mL), stirred at 90°C for four hours, cooled to room temperature, stirred for 48 hours, treated with additional hydrogen peroxide (1 mL), stirred for several hours at reflux, cooled and diluted with an ethyl acetate/water mixture. The organic phase is separated, dried over anhydrous magnesium sulfate and concentrated in vacuo to obtain an oil. Crystallization of the oil from petroleum ether gives a white semi-solid which is chromatographed using silica gel and a 1:9 ethyl acetate/hexanes solution to obtain the title product as a white solid (mp 167°-169°C) which is identified by ¹HNMR, ¹⁹FNMR and ¹³CNMR spectral analyses.

EXAMPLE 49

Preparation of 3-Bromo-5-(p-chlorophenyl)-1-(ethoxymethyl)-2-(trifluoromethyl)-4-[(trifluoromethyl)thio]pyrrole



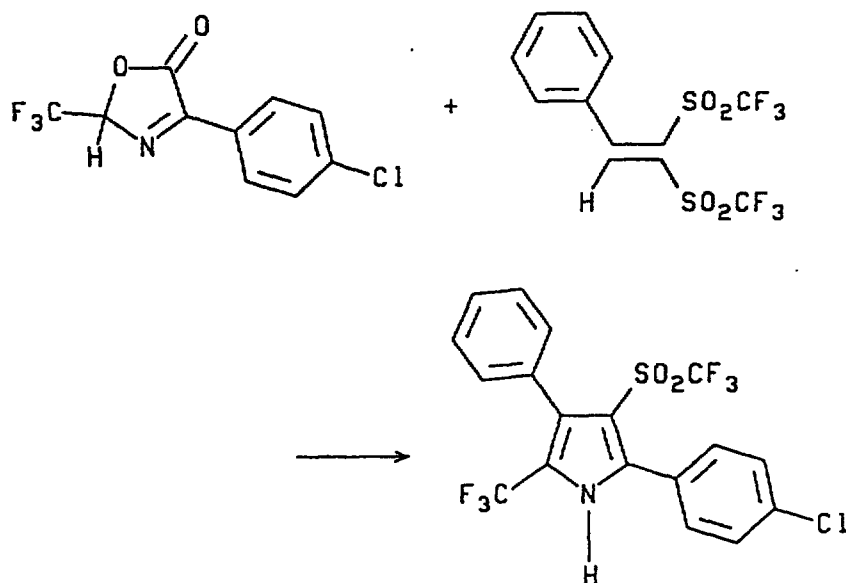
A solution of 3-bromo-5-(p-chlorophenyl)-2-(trifluoromethyl)-4-[(trifluoromethyl)thio]pyrrole (0.6 g, 1.4 mmol) and potassium tert-butoxide (0.19 g, 1.7 mmol) in tetrahydrofuran is stirred for 15 minutes, treated with chloromethyl ethyl ether (0.16 g,

1.7 mmol), stirred for 30 minutes and diluted with an ether/water mixture. The organic phase is separated, dried over anhydrous magnesium sulfate and concentrated in vacuo to obtain a residue. Chromatography of the residue using silica gel and a 1:9 ethyl acetate/-hexanes solution gives the title product as an amber oil which is identified by ^1H NMR and ^{13}C NMR spectral analyses.

Following the above procedure, but substituting 2-(p-chlorophenyl)-5-(trifluoromethyl)-3-[(trifluoromethyl)sulfinyl]pyrrole for 3-bromo-5-(p-chlorophenyl)-2-(trifluoromethyl)-4-[(trifluoromethyl)thio]pyrrole yields 2-(p-chlorophenyl)-1-(ethoxymethyl)-5-(trifluoromethyl)-3-[(trifluoromethyl)sulfinyl]pyrrole as an oil.

EXAMPLE 50

Preparation of 2-(p-Chlorophenyl)-4-phenyl-5-(trifluoromethyl)-3-[(trifluoromethyl)sulfonyl]pyrrole

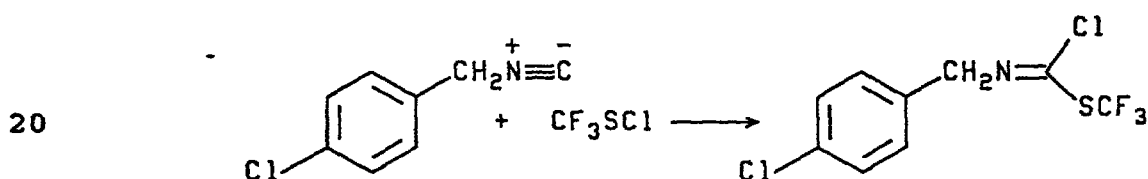


A solution of 4-(p-chlorophenyl)-2-(trifluoromethyl)-3-oxazolin-5-one (1.0 g, 3.8 mmol) and

5 β,β -bis[(trifluoromethyl)sulfonyl]styrene (1.4 g, 3.8 mmol) in dimethylformamide is stirred for two hours at 110°C, treated with triethylamine (0.38 g, 3.8 mmol), stirred for several hours at reflux and diluted with an ethyl acetate/water mixture. The organic phase is separated, washed with water and dilute hydrochloric acid, dried over anhydrous magnesium sulfate and concentrated in vacuo to obtain a residue. Chromatography of the residue using silica gel and a 1:10 ethyl acetate/hexanes solution gives the title product as an amber oil which is identified by ¹HNMR and ¹³CNMR spectral analyses.

15 EXAMPLE 51

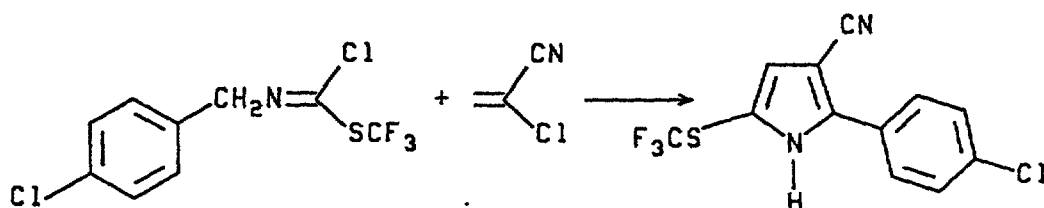
Preparation of Trifluoromethyl 1-chloro-N-(p-chlorobenzyl)thioformimidate



Trifluoromethylsulfenyl chloride (4.0 g, 0.03 mol) is bubbled over 30 minutes into a solution of 4-chlorobenzylisocyanide (3.0 g, 0.02 mol) in methylene chloride, causing the formation of a white precipitate. The suspension is stirred for 16 hours at room temperature and filtered to remove solids. The white filter cake is washed with methylene chloride and solvent is removed under reduced pressure to obtain an amber oil. Bulb-to-bulb distillation of the oil (90°-100°C, 0.05 mmHg) gives the title product as a colorless oil (3.9 g, 68%).

EXAMPLE 52

Preparation of 2-(p-Chlorophenyl)-5-[(trifluoromethyl)-thio]pyrrole-3-carbonitrile



15 Under a nitrogen purge, a solution of tri-fluoromethyl-1-chloro-N-(p-chlorobenzyl)thioformimidate (1.1 g, 0.004 mol) and 2-chloroacrylonitrile (0.4 mL, 0.005 mol) is treated with a solution of triethylamine (1.3 mL, 0.009 mol) in toluene. After an induction period, solids begin to form as the reaction mixture exotherms slightly. When the exotherm subsides, the reaction mixture is heated at reflux temperature for 16 hours, cooled and filtered. The filter cake is washed with ethyl acetate and the filtrate is concentrated in vacuo to obtain a semi-solid. The semi-solid is dissolved in ethyl acetate and the organic solution is washed with water and brine, dried over anhydrous magnesium sulfate and concentrated in vacuo to obtain a solid. The solid is twice recrystallized from 1,2-dichloroethane to give the title product as a beige solid (0.7 g, mp 203^o-205^oC) which is identified by ¹HNMR spectral analysis.

20

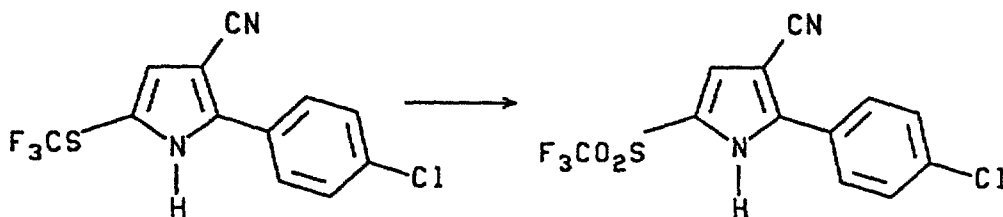
25

30

35

EXAMPLE 53

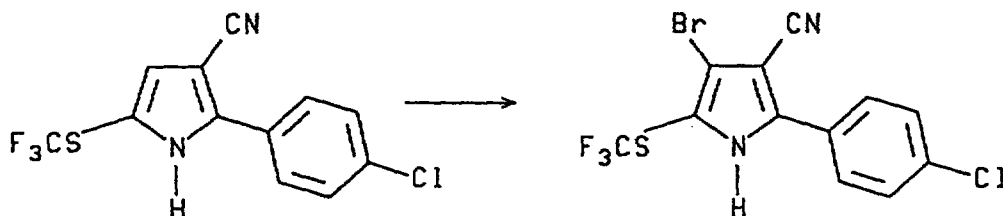
Preparation of 2-(p-chlorophenyl)-5-[(trifluoromethyl)-sulfonyl]pyrrole-3-carbonitrile



15 A solution of 2-(p-chlorophenyl)-5-[(tri-
fluoromethyl)thio]pyrrole-3-carbonitrile (0.6 g, 0.002
mol) in acetic acid is treated portionwise with 30%
hydrogen peroxide solution (0.6 mL, 0.006 mol), stirred
for 1 1/2 hours at 90°C, treated with additional
20 hydrogen peroxide (0.3 mL, 0.003 mol), stirred for two
hours at 90°C, stirred for 16 hours at room temperature
and diluted with an ethyl acetate/water mixture. The
organic phase is separated, washed with water and
25 brine, dried over anhydrous magnesium sulfate and
concentrated in vacuo to obtain a solid. The solid is
recrystallized from ethylene dichloride to give the
title product as a beige solid (mp 228°-230°C) which is
identified by ¹HNMR and ¹³CNMR spectral analyses.

EXAMPLE 54

Preparation of 4-Bromo-2-(p-chlorophenyl)-5-[(tri-
fluoromethyl)thio]pyrrole-3-carbonitrile

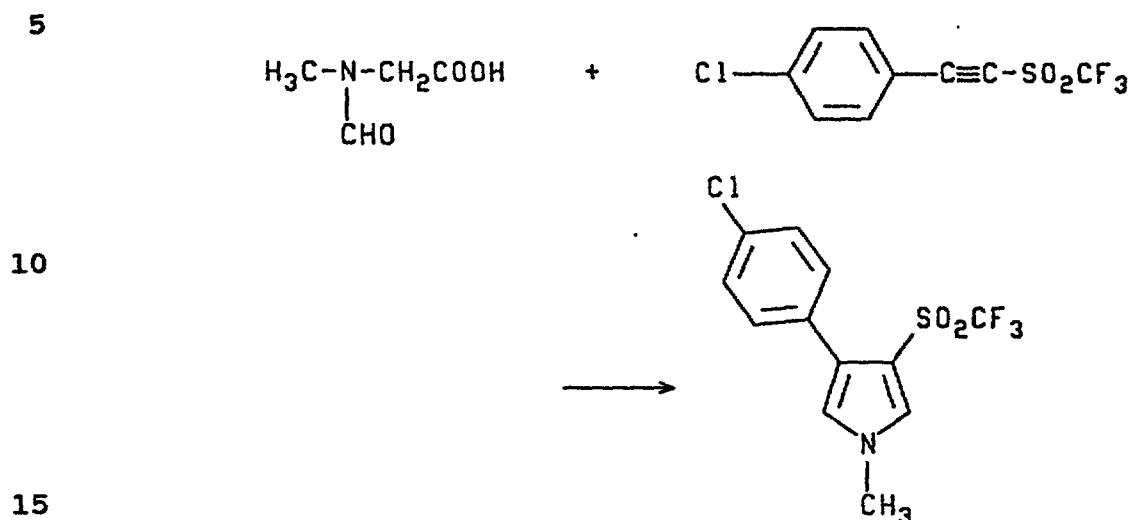


Under a nitrogen purge, a solution of 2-(p-
chlorophenyl)-5-[(trifluoromethyl)thio]pyrrole-3-

carbonitrile (0.6 g, 0.002 mol) in tetrahydrofuran is treated with N-bromosuccinimide (0.36 g, 0.002 mol), stirred for 16 hours at room temperature and concentrated in vacuo to obtain a residue. The residue is dissolved in ether and diluted with water. The organic phase is separated, washed with water and brine, dried over anhydrous magnesium sulfate and concentrated in vacuo to obtain a solid. High performance liquid chromatography indicates that the solid contains 20% starting material. A solution of the mixture and sodium acetate (0.05 g, 0.006 mol) in acetic acid is treated with bromine (0.03 mL, 0.0006 mol), stirred for 16 hours at 60°C, cooled and concentrated in vacuo to obtain a semi-solid. The semi-solid is partitioned between ethyl acetate and water. The organic phase is separated, washed with water and brine, dried over anhydrous magnesium sulfate and concentrated in vacuo to obtain a solid. The solid is recrystallized from ethylene dichloride to give the title product as an off-white solid (mp 241°C-243°C) which is identified by ¹HNMR and ¹³CNMR spectral analyses.

EXAMPLE 55

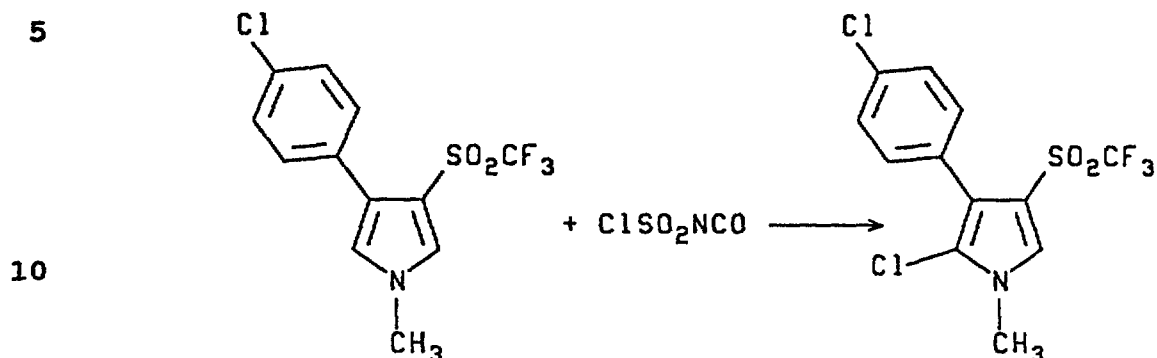
Preparation of 3-(p-Chlorophenyl)-1-methyl-4-[(tri-fluoromethyl)sulfonyl]pyrrole



A solution of 2-(p-chlorophenyl)ethynyl tri-
 fluoromethylsulfone (4.8 g, 0.018 mol) and N-formyl-
 sarcosine (2.9 g, 0.025 mol) in acetic anhydride is
 stirred for three hours at reflux temperature, stirred
 overnight at room temperature, concentrated in vacuo,
 diluted with water and extracted with ether. The
 combined organic extracts are concentrated in vacuo to
 obtain a residue. Flash chromatography of the residue
 using silica gel and a 1:3 ethyl acetate/hexanes
 solution gives a brown solid which is recrystallized
 from a benzene/hexanes solution to obtain the title
 product as a white solid (1.9 g, mp 70^o-73^oC) which is
 identified by ¹HNMR and ¹³CNMR spectral analyses.

EXAMPLE 56

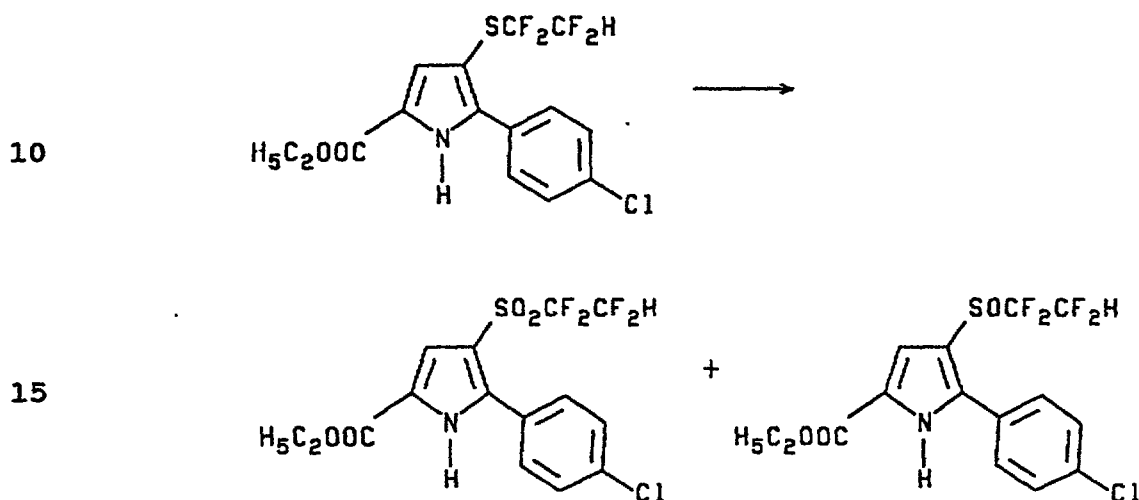
Preparation of 2-Chloro-3-(p-chlorophenyl)-1-methyl-4-[(trifluoromethyl)sulfonyl]pyrrole



A solution of 3-(p-chlorophenyl)-1-methyl-4-[(trifluoromethyl)sulfonyl]pyrrole (0.5 g, 0.0015 mol) in dimethoxyethane is treated with chlorosulfonyl isocyanate (0.3 mL, 0.0034 mol), stirred for 24 hours at room temperature, treated with additional chlorosulfonyl isocyanate (0.6 mL, 0.0068 mol), stirred for 24 hours, treated with dimethylformamide (2 mL), stirred for one hour, diluted with water and extracted with ether. The combined organic extractes are washed with water, dried and concentrated in vacuo to obtain a semi-solid. Flash chromatography of the semi-solid using silica gel and a 1:4 ethyl acetate/hexanes solution gives the title product as a white solid (0.2 g, mp 117°C - 119°C) which is identified by ^1H NMR and ^{13}C NMR spectral analyses.

EXAMPLE 57

Preparation of Ethyl 5-(p-chlorophenyl)-4-[(1,1,2,2-tetrafluoroethyl)sulfonyl]pyrrole-2-carboxylate and Ethyl 5-(p-chlorophenyl)-4-[(1,1,2,2-tetrafluoroethyl)sulfinyl]pyrrole-2-carboxylate



20 A solution of ethyl 5-(p-chlorophenyl)-4-[(1,1,2,2-tetrafluoroethyl)thio]pyrrole-2-carboxylate (1.83 g, 0.0022 mol) in chloroform is cooled with an ice bath, treated with 3-chloroperoxybenzoic acid (3.2 g, 0.011 mol), stirred for one hour, warmed to room temperature, stirred for several hours, cooled with an ice bath, treated with additional 3-chloroperoxybenzoic acid (2.7 g, 60%, 0.009 mol), stirred for several hours, treated with saturated sodium metabisulfite solution and diluted with a methylene chloride/water mixture. The organic phase is separated, washed with saturated sodium hydrogen carbonate solution, dried over anhydrous sodium sulfate and concentrated in vacuo to obtain a residue. Flash chromatography of the residue using silica gel and a 1:5 ethyl acetate/hexanes solution gives ethyl 5-(p-chlorophenyl)-4-[(1,1,2,2-tetrafluoroethyl)sulfonyl]pyrrole-2-carboxylate as a white solid (0.54 g,

35

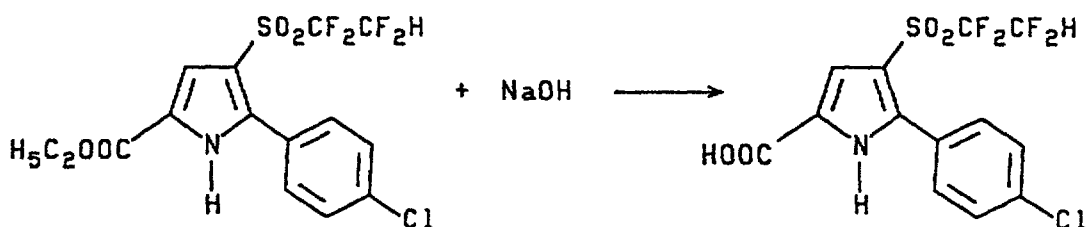
153°-156°C) and ethyl 5-(p-chlorophenyl)-4-[(1,1,2,2-tetrafluoroethyl)sulfinyl]pyrrole-2-carboxylate as a white solid (1.28 g, mp 138°-140°C). Both products are identified by ¹HNMR and ¹³CNMR spectral analyses.

5

EXAMPLE 58

Preparation of 5-(p-Chlorophenyl)-4-[(1,1,2,2-tetrafluoroethyl)sulfonyl]pyrrole-2-carboxylic acid

10



15

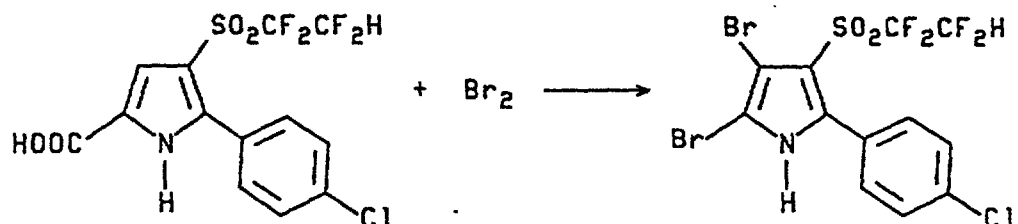
A solution of ethyl 5-(p-chlorophenyl)-4-[(1,1,2,2-tetrafluoroethyl)sulfonyl]pyrrole-2-carboxylate (0.54 g, 0.0012 mol) in ethanol is treated under nitrogen with a solution of sodium hydroxide (0.26 g, 0.0065 mol) in water. The reaction mixture is refluxed for three hours, poured into ice-water, treated with hydrochloric acid and extracted with ethyl acetate. The combined organic extracts are washed with water and brine, dried over anhydrous sodium sulfate and concentrated in vacuo to obtain the title product as a gum (0.6 g).

30

35

EXAMPLE 59

Preparation of 2,3-Dibromo-5-(p-chlorophenyl)-4-
[(1,1,2,2-tetrafluoroethyl)sulfonyl]pyrrole



15

A solution of 5-(p-chlorophenyl)-4-[(1,1,2,2-tetrafluoroethyl)sulfonyl]pyrrole-2-carboxylic acid (0.5 g, 0.0013 mol) and sodium acetate (0.47 g, 0.0057 mol) in acetic acid is treated with a solution of bromine (0.46 g, 0.0029 mol) in acetic acid, stirred for two hours at 60°C, poured into ice-water and extracted with ethyl acetate. The combined organic extracts are washed with water, saturated sodium hydrogen carbonate solution and brine, dried over anhydrous sodium sulfate and concentrated in vacuo to obtain a red gum. Flash chromatography of the gum using silica gel and a 1:6 ethyl acetate/hexanes solution gives the title product as a pale green solid (0.37 g, mp 138°-141°C) which is identified by ¹HNMR and ¹³CNMR spectral analyses.

20

25

EXAMPLE 60

Insecticide and acaricide evaluations

30

The following tests show the efficacy of the compounds as insecticides and acaricides. The evaluations are conducted with solutions of test compounds dissolved or dispersed in 50/50 acetone/water mixtures. The test compound is technical material dissolved or dispersed in said acetone/water mixtures in sufficient

35

amount to provide the concentrations set forth in Table I below.

5 All concentrations reported herein are in terms of active ingredient. All tests are conducted in a laboratory maintained at about 27°C. The rating system employed is as follows:

Rating System

10	0 = no effect	5 = 56-65% kill
	1 = 10-25% kill	6 = 66-75% kill
	2 = 26-35% kill	7 = 76-85% kill
	3 = 36-45% kill	8 = 86-99% kill
	4 = 46-55% kill	9 = 100% kill

15

The test species of insects used in the present evaluations along with specific test procedures are described below.

20 Spodoptera eridania 3rd instar larvae, southern army-worm

A sieva lima bean leaf expanded to 7 to 8 cm in length is dipped in the test suspension with agitation for 3 seconds and placed in a hood to dry. The leaf is then placed in a 100x10 mm petri dish containing a damp filter paper on the bottom and 10 3rd instar caterpillars. The dish is maintained for 5 days before observations are made of mortality, reduced feeding, or any interference with normal moulting.

30 Spodoptera eridania 7-day residual

The plants treated in the above test are maintained under high intensity lamps in the greenhouse for 7 days. These lamps duplicate the effects of a bright sunny day and are kept on for 14 hour day

35

length. After 7 days, the foliage is sampled and assayed as in the above-said test.

5 Tetranychus urticae (P-resistant strain), 2-spotted spider mite

 Sieva lima bean plants with primary leaves expanded to 7 to 8 cm are selected and cut back to one plant per pot. A small piece is cut from a leaf taken from the main colony and placed on each leaf of the test plants. This is done about 2 hours before treatment to allow the mites to move over to the test plant and to lay eggs. The size of the cut piece is varied to obtain about 100 mites per leaf. At the time of the treatment, the piece of leaf used to transfer the mites is removed and discarded. The mite-infested plants are dipped in the test formulation for 3 seconds with agitation and set in the hood to dry. Plants are kept for 2 days before estimates of adult kill are made using the first leaf. The second leaf is kept on the plants for another 5 days before observations are made of the kill of eggs and/or newly emerged nymphs.

Empoasca abrupta, adults, western potato leafhopper

25 A Sieva lima bean leaf about 5 cm long is dipped in the test formulation for 3 seconds with agitation and placed in a hood to dry. The leaf is placed in a 100x10 mm petri dish containing a moist filter paper on the bottom. About 10 adult leafhoppers are added to each dish and the treatments are kept for 30 3 days before mortality counts are made.

Heliothis virescens, 3rd instar tobacco budworm

35 Cotton cotyledons are dipped in the test formulation and allowed to dry in a hood. When dry, each is cut into quarters and ten sections placed

individually in 30 mL plastic medicine cups containing
a 5 to 7 mm long piece of damp dental wick. One 3rd
instar caterpillar is added to each cup and a cardboard
5 lid placed on the cup. Treatments are maintained for 3
days before mortality counts and estimates of reduction
in feeding damage are made.

The data obtained for the above described
10 evaluations are reported in Table I.

15

20

25

30

35

TABLE I
Insecticide And Acaricide Evaluations

<u>Compound</u>	<u>Southern Armyworm</u>		<u>P. Res</u>	<u>Leaf-</u>	<u>Tobacco</u>
			<u>mite</u>	<u>hopper</u>	<u>Budworm</u>
	(ppm) <u>1,000</u>	7 <u>days</u>	(ppm) <u>300</u>	(ppm) <u>100</u>	(ppm) <u>1,000</u>
2-(p-Chlorophenyl)-3-[(trifluoromethyl)sulfonyl]pyrrole	9	-	0	0	0
2,3-Dibromo-5-(p-chlorophenyl)-4-[(trifluoromethyl)sulfonyl]pyrrole	9	9	7	9	9
2,3-Dichloro-5-(p-chlorophenyl)-4-[(trifluoromethyl)sulfonyl]pyrrole	9	9	9	9	9
5-(p-Chlorophenyl)-4-[(trifluoromethyl)sulfonyl]pyrrole-2-carbonitrile	9	9	9	9	9

TABLE I (Continued)

<u>Compound</u>	<u>Southern Armyworm</u>		<u>P. Res</u>	<u>Leaf-</u>	<u>Tobacco</u>
	(ppm) <u>1,000</u>	7 <u>days</u>	<u>mite</u> (ppm) <u>300</u>	<u>hopper</u> (ppm) <u>100</u>	<u>Budworm</u> (ppm) <u>1,000</u>
5-Bromo-2-(p-chlorophenyl)-3- [(trifluoromethyl)sulfonyl]pyrrole	9	9	9	8	9
5-Chloro-2-(p-chlorophenyl)-3- [(trifluoromethyl)sulfonyl]pyrrole	9	9	9	8	9
2-(p-Chlorophenyl)-5-nitro-3- [(trifluoromethyl)sulfonyl]pyrrole	9	9	0	0	9
2,3-Dibromo-5-phenyl-4-[(trifluoro- methyl)sulfonyl]pyrrole	9	9	9	9	9

TABLE I (Continued)

<u>Compound</u>	<u>Southern Armyworm</u>		<u>P. Res</u>	<u>Leaf-</u>	<u>Tobacco</u>
	(ppm) <u>1,000</u>	7 <u>days</u>	<u>mite</u> (ppm) <u>300</u>	<u>hopper</u> (ppm) <u>100</u>	<u>Budworm</u> (ppm) <u>1,000</u>
2,3-Dibromo-5-(p-bromophenyl)- 4-[(trifluoromethyl)sulfonyl]pyrrole	9	9	9	8	9
2,3-Dibromo-4-[(trifluoromethyl)- sulfonyl]-5-(alpha, alpha, alpha- trifluoro-p-tolyl)pyrrole	9	9	9	8	9
2,3-Dibromo-5-(p-chlorophenyl)-1- (ethoxymethyl)-4-[(trifluoromethyl)- sulfonyl]pyrrole	9	9	0	9	9
2,3-Dibromo-5-(p-tert-butylphenyl)- 4-[(trifluoromethyl)sulfonyl]pyrrole	9	9	0	6	0

TABLE I (Continued)

<u>Compound</u>	<u>Southern Armyworm</u>		<u>P. Res</u>	<u>Leaf-</u>	<u>Tobacco</u>
	(ppm) <u>1,000</u>	7 <u>days</u>	<u>mite</u> (ppm) <u>300</u>	<u>hopper</u> (ppm) <u>100</u>	<u>Budworm</u> (ppm) <u>1,000</u>
2,3-Dibromo-1-(chloromethyl)-5-(p-chlorophenyl)-4-[(trifluoromethyl)sulfonyl]pyrrole	9	9	0	0	4
5-(p-Bromophenyl)-2,3-dichloro-4-[(trifluoromethyl)sulfonyl]pyrrole	9	9	9	6	9
3-Bromo-5-(p-chlorophenyl)-4-[(trifluoromethyl)sulfonyl]pyrrole-2-carbonitrile	9	9	5	0	9
(2,3-Dibromo-5-(p-chlorophenyl)-4-[(trifluoromethyl)sulfonyl]pyrrol-1-yl)methyl dimethyldithiocarbamate	9	9	4	0	9

TABLE I (Continued)

<u>Compound</u>	<u>Southern Armyworm</u>		<u>P. Res</u>	<u>Leaf-</u>	<u>Tobacco</u>
	(ppm)	7	<u>mite</u>	<u>hopper</u>	<u>Budworm</u>
	<u>1,000</u>	<u>days</u>	(ppm) <u>300</u>	(ppm) <u>100</u>	(ppm) <u>1,000</u>
2,3-Dibromo-5-(p-chlorophenyl)-4- [(trifluoromethyl)sulfonyl]pyrrole- 1-acetonitrile	9	9	0	0	9
3,4-Dibromo-2-(p-chlorophenyl)-5- [(trifluoromethyl)thio]pyrrole	9	9	9	0	9
3,4-Dibromo-2-(p-chlorophenyl)-5- [(trifluoromethyl)sulfonyl]pyrrole	9	9	9	9	9
2-(p-Chlorophenyl)-5-[(trifluoro- methyl)thio]pyrrole	7	0	9	0	0

TABLE I (Continued)

<u>Compound</u>	<u>Southern Armyworm</u>		<u>P. Res</u>	<u>Leaf-</u>	<u>Tobacco</u>
	(ppm)	7	<u>mite</u>	<u>hopper</u>	<u>Budworm</u>
	<u>1,000</u>	<u>days</u>	(ppm) <u>300</u>	(ppm) <u>100</u>	(ppm) <u>1,000</u>
(2,3-Dibromo-5-(p-chlorophenyl)-4- [(trifluoromethyl)sulfonyl]pyrrol- 1-yl)methyl p-toluate	9	9	0	0	9
(2,3-Dibromo-5-(p-chlorophenyl)-4- [(trifluoromethyl)sulfonyl]pyrrol- 1-yl)methyl p-chlorohippurate	9	9	9	0	9
2,3-Dibromo-5-(p-fluorophenyl)-3- [(trifluoromethyl)sulfonyl]pyrrole	9	9	0	8	9
2,3-Dibromo-5-(3,4-dichlorophenyl)- 4-[(trifluoromethyl)sulfonyl]pyrrole	9	9	0	0	9

TABLE I (Continued)

<u>Compound</u>	<u>Southern Armyworm</u>		<u>P. Res</u>	<u>Leaf-</u>	<u>Tobacco</u>
	(ppm)	7	<u>mite</u>	<u>hopper</u>	<u>Budworm</u>
	<u>1,000</u>	<u>days</u>	(ppm)	(ppm)	(ppm)
			<u>300</u>	<u>100</u>	<u>1,000</u>
3,4-Dibromo-2-(p-chlorophenyl)-5- [(trifluoromethyl)sulfinyl]pyrrole	9	9	0	9	9
3-Bromo-2-(p-chlorophenyl)-5- [(trifluoromethyl)sulfonyl]pyrrole	9	-	0	9	9
3-Bromo-2-(p-chlorophenyl)-5- [(trifluoromethyl)sulfinyl]pyrrole	9	5	0	8	9
3-Bromo-2-(p-chlorophenyl)-5- [(trifluoromethyl)thio]pyrrole	9	9	0	0	9

TABLE I (Continued)

<u>Compound</u>	<u>Southern Armyworm</u>		<u>P. Res</u>	<u>Leaf-</u>	<u>Tobacco</u>
	(ppm) <u>1,000</u>	7 <u>days</u>	<u>mite</u> (ppm) <u>300</u>	<u>hopper</u> (ppm) <u>100</u>	<u>Budworm</u> (ppm) <u>1,000</u>
2-(p-Chlorophenyl)-4-phenyl-5-(trifluoromethyl)-3-[(trifluoromethyl)sulfonyl]pyrrole	-	-	-	8	-
2,3-Dichloro-5-(3,4-dichlorophenyl)-4-[(trifluoromethyl)sulfonyl]pyrrole	9	9	9	5	9
2-(p-Chlorophenyl)-5-[(trifluoromethyl)thio]pyrrole-3-carbonitrile	9	9	9	5	9
2,3-Dibromo-5-p-tolyl-4-[(trifluoromethyl)sulfonyl]pyrrole	9	9	0	0	9

TABLE I (Continued)

<u>Compound</u>	<u>Southern Armyworm</u>		<u>P. Res</u>	<u>Leaf-</u>	<u>Tobacco</u>
	(ppm)	7	<u>mite</u>	<u>hopper</u>	<u>Budworm</u>
	<u>1,000</u>	<u>days</u>	(ppm) <u>300</u>	(ppm) <u>100</u>	(ppm) <u>1,000</u>
p-(2,3-Dibromo-4-[(trifluoromethyl)-sulfonyl]pyrrol-2-yl)benzonitrile	9	9	9	0	9
p-(5-Bromo-3-[(trifluoromethyl)-sulfonyl]pyrrol-2-yl)benzonitrile	9	9	0	9	9
2,5-Dibromo-3-(p-chlorophenyl)-4-[(trifluoromethyl)sulfonyl]pyrrole	9	-	0	-	-
2-Bromo-3-(p-chlorophenyl)-4-[(trifluoromethyl)sulfonyl]pyrrole	9	-	0	-	-

TABLE I (Continued)

<u>Compound</u>	<u>Southern Armyworm</u>		<u>P. Res</u>	<u>Leaf-</u>	<u>Tobacco</u>
	(ppm) <u>1,000</u>	7 <u>days</u>	<u>mite</u> (ppm) <u>300</u>	<u>hopper</u> (ppm) <u>100</u>	<u>Budworm</u> (ppm) <u>1,000</u>
3,4-Dibromo-2-(p-chlorophenyl)-5- [(difluoromethyl)thio]pyrrole	9	9	0	9	9
3,4-Dibromo-2-(p-chlorophenyl)-5- [(difluoromethyl)sulfonyl]pyrrole	9	9	0	9	9
2,3-Dichloro-5-p-tolyl-4-[(tri- fluoromethyl)sulfonyl]pyrrole	9	-	0	-	-
2-Chloro-3-(p-chlorophenyl)-1-methyl- 4-[(trifluoromethyl)sulfonyl]pyrrole	9	-	0	-	-

TABLE I (Continued)

<u>Compound</u>	<u>Southern Armyworm</u>		<u>P. Res</u>	<u>Leaf-</u>	<u>Tobacco</u>
	(ppm)	7	<u>mite</u>	<u>hopper</u>	<u>Budworm</u>
	<u>1,000</u>	<u>days</u>	(ppm)	(ppm)	(ppm)
			<u>300</u>	<u>100</u>	<u>1,000</u>
2-(p-Chlorophenyl)-3-nitro-5- [(trifluoromethyl)sulfonyl]pyrrole	9	-	0	0	0
5-(p-Chlorophenyl)-3-nitro-2- [(trifluoromethyl)thio]pyrrole	9	-	0	-	-
2-(p-Chlorophenyl)-3-nitro-5- [(trifluoromethyl)thio]pyrrole	9	-	0	9	-
2,3-Dibromo-4-(p-chlorophenyl)- 5-[(trifluoromethyl)sulfinyl]- pyrrole	9	-	0	0	-

TABLE I (Continued)

<u>Compound</u>	<u>Southern Armyworm</u>		<u>P. Res</u>	<u>Leaf-</u>	<u>Tobacco</u>
	(ppm) <u>1,000</u>	7 <u>days</u>	<u>mite</u> (ppm) <u>300</u>	<u>hopper</u> (ppm) <u>100</u>	<u>Budworm</u> (ppm) <u>1,000</u>
2-(p-Chlorophenyl)-5-(trifluoromethyl)-3-[(trifluoromethyl)thio]pyrrole	9	-	0	0	-
2-(p-Chlorophenyl)-5-(trifluoromethyl)-3-[(trifluoromethyl)sulfinyl]pyrrole	9	-	0	0	9
2,3-Dibromo-4-(p-chlorophenyl)-5-[(trifluoromethyl)thio]pyrrole	9	-	9	0	-
3-(p-Chlorophenyl)-2-[(trifluoromethyl)thio]pyrrole	9	-	8	0	-

TABLE I (Continued)

<u>Compound</u>	<u>Southern Armyworm</u>		<u>P. Res</u>	<u>Leaf-</u>	<u>Tobacco</u>
	(ppm) <u>1,000</u>	7 <u>days</u>	<u>mite</u> (ppm) <u>300</u>	<u>hopper</u> (ppm) <u>100</u>	<u>Budworm</u> (ppm) <u>1,000</u>
2,3-Dibromo-5-(p-chlorophenyl)- 4-[(difluoromethyl)sulfinyl]- pyrrole	9	-	0	0	-
4-Bromo-2-(p-chlorophenyl)-5- [(trifluoromethyl)thio]pyrrole- 3-carbonitrile	9	-	0	5	9
2-(p-Chlorophenyl)-5-[(trifluoro- methyl)sulfonyl]pyrrole-3-carbo- nitrile	9	-	9	4	-
3,4-Dibromo-2-(3,4-dichlorophenyl)- 5-[(trifluoromethyl)thio]pyrrole	9	-	9	7	9

TABLE I (Continued)

<u>Compound</u>	<u>Southern Armyworm</u>		<u>P. Res</u>	<u>Leaf-</u>	<u>Tobacco</u>
	(ppm) <u>1,000</u>	7 <u>days</u>	<u>mite</u> (ppm) <u>300</u>	<u>hopper</u> (ppm) <u>100</u>	<u>Budworm</u> (ppm) <u>1,000</u>
3,4-Dibromo-2-(3,4-dichlorophenyl)- 5-[(trifluoromethyl)sulfonyl]pyrrole	9	-	9	9	-
2-(3,4-Dichlorophenyl)-5-[(trifluoro- methyl)thio]pyrrole	9	-	9	0	-
2-(p-Chlorophenyl)-3-[(trifluoro- methyl)sulfonyl]-5-[(trifluoro- methyl)thio]pyrrole	9	-	9	9	-
2,3-Dibromo-5-(p-methoxyphenyl)-4- [(trifluoromethyl)sulfonyl]pyrrole	9	-	0	0	-

TABLE I (Continued)

<u>Compound</u>	<u>Southern Armyworm</u>		<u>P. Res</u>	<u>Leaf-</u>	<u>Tobacco</u>
	(ppm) <u>1,000</u>	7 <u>days</u>	<u>mite</u> (ppm) <u>300</u>	<u>hopper</u> (ppm) <u>100</u>	<u>Budworm</u> (ppm) <u>1,000</u>
3-Bromo-5-(p-chlorophenyl)-2-(trifluoromethyl)-4-[(trifluoromethyl)-thio]pyrrole	9	-	8	-	-
2-(p-Chlorophenyl)-5-(trifluoromethyl)-3-[(trifluoromethyl)sulfonyl]pyrrole	9	-	9	-	-
3-Bromo-5-(p-chlorophenyl)-1-(ethoxymethyl)-2-(trifluoromethyl)-4-[trifluoromethyl]thio]pyrrole	9	-	0	-	-
3,4-Dibromo-2-(p-chlorophenyl)-5-[(difluoromethyl)sulfinyl]pyrrole	9	-	0	-	-

TABLE I (Continued)

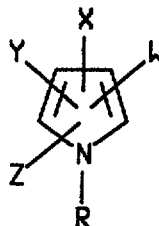
<u>Compound</u>	<u>Southern Armyworm</u>		<u>P. Res</u>	<u>Leaf-</u>	<u>Tobacco</u>
	(ppm)	7	<u>mite</u>	<u>hopper</u>	<u>Budworm</u>
	<u>1,000</u>	<u>days</u>	(ppm) <u>300</u>	(ppm) <u>100</u>	(ppm) <u>1,000</u>
3,4-Dibromo-2-(3,4-dichlorophenyl)- 1-(ethoxymethyl)-5-[(trifluoro- methyl)sulfonyl]pyrrole	9	-	0	-	-
3-Bromo-5-(p-chlorophenyl)-4- [(trifluoromethyl)sulfonyl]-2- [(trifluoromethyl)thio]pyrrole	9	-	9	-	-
3,5-Bis[(trifluoromethyl)sulfonyl]- 2-(p-chlorophenyl)pyrrole	9	-	9	-	-
2-(p-Chlorophenyl)-3-[(trifluoro- methyl)thio]pyrrole	9	-	9	-	-



- 93 -

WHAT IS CLAIMED IS:

1. A compound having the structural formula



wherein

W is $S(O)_n CF_2 R_1$;

R_1 is H, F, Cl, Br, CF_2H , CCl_2H , $CClFH$, CF_3 or CCl_3 ;

n is an integer of 0, 1 or 2;

X is phenyl substituted with one to three halogen,

C_1 - C_3 alkyl, C_1 - C_3 alkoxy, C_1 - C_3 alkylthio, C_1 - C_3 alkylsulfinyl, C_1 - C_3 alkylsulfonyl, CN, NO_2 , CF_3 , R_2CF_2B , R_3CO or NR_4R_5 groups;

B is $S(O)_n$ or O;

R_2 is H, F, CF_2H , $CClFH$ or CF_3 ;

R_3 is C_1 - C_3 alkyl, C_1 - C_3 alkoxy or NR_4R_5 ;

R_4 is H or C_1 - C_3 alkyl;

R_5 is H or C_1 - C_3 alkyl or R_6CO ;

R_6 is H or C_1 - C_3 alkyl;

Y is H, halogen, CF_3 , CN, NO_2 , $S(O)_n CF_2 R_1$ or phenyl

substituted with one to three halogen, C_1 - C_3

alkyl, C_1 - C_3 alkoxy, C_1 - C_3 alkylthio, C_1 - C_3

alkylsulfinyl, C_1 - C_3 alkylsulfonyl, CN, NO_2 , CF_3 ,

R_2CF_2B , R_3CO or NR_4R_5 groups;

Z is H, halogen or CF_3 ;

R is H, CN, CR_7 , $R_8CHNHCR_9$, CH_2SO ,

C_1 - C_6 alkyl optionally substituted with one to

three halogen atoms,

one tri(C_1 - C_4 alkyl)silyl,

one hydroxy,





- 94 -

- one cyano,
- one or two C_1-C_4 alkoxy groups optionally substituted with one to three halogen atoms,
- one C_1-C_4 alkylthio,
- one phenyl optionally substituted with one to three halogen atoms, one to three C_1-C_4 alkyl groups or one to three C_1-C_4 alkoxy groups,
- one phenoxy group optionally substituted with one to three halogen atoms, one to three C_1-C_4 alkyl groups or one to three C_1-C_4 alkoxy groups,
- one benzyloxy group optionally substituted on the phenyl ring with one to three halogen atoms, one to three C_1-C_4 alkyl groups or one to three C_1-C_4 alkoxy groups,
- one C_1-C_6 alkylcarbonyloxy group optionally substituted with one to three halogen atoms,
- one C_2-C_6 alkenylcarbonyloxy group optionally substituted with one to three halogen atoms,
- one phenylcarbonyloxy group optionally substituted with one to three halogen atoms, one to three C_1-C_4 alkyl groups or one to three C_1-C_4 alkoxy groups,
- one C_1-C_6 alkoxy carbonyl group optionally substituted with one to three halogen atoms or one to three C_1-C_4 alkoxy groups,
- one benzylcarbonyloxy group optionally substituted on the phenyl ring with one to three halogen atoms, one to three C_1-C_4



* C L M S *



- 95 -

alkyl groups or one to three C_1-C_4
alkoxy groups, or
one 2-furylcarbonyloxy group,
 C_3-C_6 alkenyl optionally substituted with one
to three halogen atoms or one phenyl group,
or
 C_3-C_6 alkynyl optionally substituted with one
to three halogen atoms or one phenyl group;
 R_7 is C_1-C_6 alkyl or C_3-C_6 cycloalkyl each optionally
substituted with
one to three halogen atoms,
one hydroxy,
one cyano,
one or two C_1-C_4 alkoxy groups optionally substi-
tuted with one to three halogen atoms,
one C_1-C_4 alkylthio,
one phenyl group optionally substituted with one
to three halogen atoms, one to three C_1-C_4
alkyl groups or one to three C_1-C_4 alkoxy
groups,
one phenoxy group optionally substituted with one
to three halogen atoms, one to three C_1-C_4
alkyl groups or one to three C_1-C_4 alkoxy
groups,
one benzyloxy group optionally substituted on the
phenyl ring with one to three halogen atoms,
one to three C_1-C_4 alkyl groups or one to
three C_1-C_4 alkoxy groups,
one C_1-C_6 alkyl carbonyloxy group optionally sub-
stituted with one to three halogen atoms,
one C_2-C_6 alkenylcarbonyloxy group optionally sub-
stituted with one to three halogen atoms,
one phenylcarbonyloxy group optionally substi-



* C L M S *

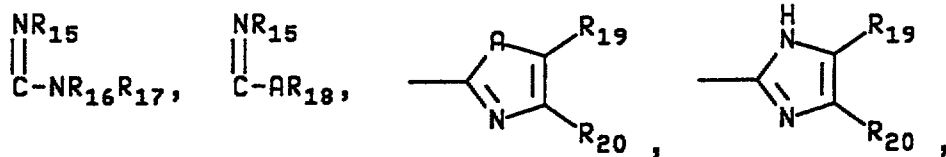
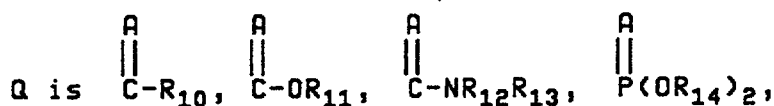


- 96 -

tuted with one to three halogen atoms, one to
 three C_1-C_4 alkyl groups or one to three
 C_1-C_4 alkoxy groups,
 one C_1-C_6 alkoxy carbonyl group optionally substi-
 tuted with one to three halogen atoms, or one
 to three C_1-C_4 alkoxy groups, or
 one benzyloxy carbonyl group optionally substi-
 tuted on the phenyl ring with one to three
 halogen atoms, one to three C_1-C_4 alkyl
 groups or one to three C_1-C_4 alkoxy groups,
 C_2-C_6 alkenyl optionally substituted with one to
 three halogen atoms or one phenyl group,
 C_3-C_6 alkynyl optionally substituted with one to
 three halogen atoms or one phenyl group,
 phenyl optionally substituted with one to three
 halogen atoms, one to three C_1-C_4 alkyl groups,
 one C_5-C_{12} alkyl group, one to two C_1-C_4 alkoxy
 groups, or one phenoxy, C_1-C_4 alkylthio, tri-
 alkylsilyl, C_1-C_4 alkylsulfinyl, C_1-C_4 alkyl-
 sulfonyl, carbo- C_1-C_4 -alkoxy, carboxy, CF_3 , CN,
 NO_2 , di(C_1-C_4 alkyl)amino, R_2CF_2B or C_1-C_4 alka-
 noylamino,
 phenoxy optionally substituted with one to three
 halogen atoms, one or two C_1-C_4 alkyl groups, one
 or two C_1-C_4 alkoxy groups, trialkylsilyl, CF_3 ,
 CN, NO_2 , or di(C_1-C_4 alkyl)amino groups, or C_1-C_4
 alkanoylamino,
 1- or 2-naphthyl,
 pyridyl, furyl, pyrrolyl or thiophenyl optionally
 substituted with one to three halogen atoms,
 C_1-C_6 alkoxy group optionally substituted with
 one to three halogen atoms; or
 C_2-C_6 alkenyloxy group optionally substituted with
 one to three halogen atoms;
 R_8 is hydrogen or C_1-C_4 alkyl;



R₉ is C₁-C₆ alkyl optionally substituted with one to three halogen atoms,
phenyl optionally substituted with one or two halogen, CN, NO₂, C₁-C₄ alkyl, C₁-C₄ alkoxy or CF₃ groups,
2- or 3-thienyl or
2- or 3-furyl;



CN, C₁-C₆ alkyl optionally substituted with one or more phenyl, CN or halogen groups or phenyl optionally substituted with one to three C₁-C₃ alkyl, C₁-C₃ alkoxy, halogen, CN, NO₂, CF₃ or NR₂₁R₂₂ groups;

A is 0 or S;

R_{10} is C_1 - C_6 alkyl or phenyl;

R_{11} is C_1-C_6 alkyl;

R_{12} and R_{13} are each independently hydrogen, C_1-C_6 alkyl or when taken together with the atom to which they are attached may form a 5- to 7- membered ring wherein $R_{12}R_{13}$ represents from 4 to 6 hydrocarbons;

R_{14} is C_1 - C_4 alkyl;

R_{15} is hydrogen, C_1-C_4 alkyl or may be taken together





- 98 -

with either R_{16} or R_{18} and the atoms to which they are attached to form a 5- to 7-membered ring optionally substituted with one or two C_1-C_3 alkyl groups;

R_{16} and R_{17} are each independently hydrogen or C_1-C_4 alkyl;

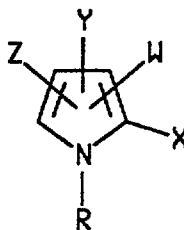
R_{18} is C_1-C_4 alkyl or when taken together with R_{15} and the atoms to which they are attached may form a 5- to 7- membered ring optionally substituted with one or two C_1-C_3 alkyl groups;

R_{19} and R_{20} are each independently hydrogen or C_1-C_3 alkyl or when taken together may form a ring wherein $R_{19}R_{20}$ is represented by $-C=C-C-$; and

R_{21} and R_{22} are each independently hydrogen or C_1-C_3 alkyl;

provided that when R is H or C_1-C_6 alkyl, X is attached to a carbon atom adjacent to the pyrrole ring nitrogen atom; and when Y is substituted phenyl, X and Y cannot be attached to the pyrrole ring at positions two and three.

2. The compound according to claim 1 wherein said compound has the structural formula



wherein W is $S(O)_n CF_2 R_1$;

X is phenyl substituted with one to three halogen, CN, NO_2 , CF_3 or $R_2 CF_2 B$ groups;

Y is Cl, Br, CF_3 , CN or $S(O)_n CF_2 R_1$;

Z is H, Cl, Br or CF_3 ;



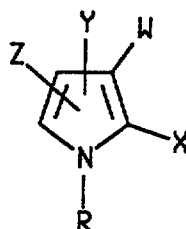


- 99 -

O
 $\parallel$
 R is H, CN, CR_7 or $\text{C}_1\text{-C}_4$ alkyl optionally substituted with one to three halogen atoms, one $\text{C}_1\text{-C}_4$ alkoxy group, one cyano, one $\text{C}_1\text{-C}_6$ alkylcarbonyloxy group, one phenylcarbonyloxy group optionally substituted with one to three halogen atoms or one $\text{C}_1\text{-C}_4$ alkyl group, one benzylcarbonyloxy group or one 2-furylcarbonyloxy group; and

R_7 is phenyl optionally substituted with one to three halogen atoms, one or two $\text{C}_1\text{-C}_4$ alkyl groups, one or two $\text{C}_1\text{-C}_4$ alkoxy groups, CF_3 , CN, NO_2 or $\text{R}_2\text{CF}_2\text{B}$.

3. The compound according to claim 2 wherein said compound has the structural formula



wherein W is SO_nCF_3 ;

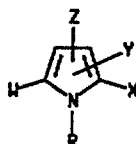
X is phenyl substituted with one to three halogen atoms or CF_3 ;

Y is Cl, Br, CF_3 , CN or $\text{S(O)}_n\text{CF}_3$;

Z is H, Cl, Br or CF_3 ; and

R is H or $\text{C}_1\text{-C}_4$ alkyl substituted with one $\text{C}_1\text{-C}_4$ alkoxy group.

4. The compound according to claim 2 wherein said compound has the structural formula





wherein W is SO_nCF_3 ;

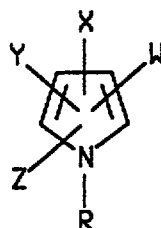
X is phenyl substituted with one to three halogen atoms or CF_3 ;

Y is Cl, Br, CF_3 , CN or $\text{S(O)}_n\text{CF}_3$;

Z is H, Cl, Br or CF_3 ; and

R is H or $\text{C}_1\text{-C}_4$ alkyl substituted with one $\text{C}_1\text{-C}_4$ alkoxy group.

5. A method for controlling insects and acarina which comprises contacting said insects and acarina, their breeding grounds, food supply or habitat with an insecticidally or acaricidally effective amount of a compound having the structural formula



wherein

W is $\text{S(O)}_n\text{CF}_2\text{R}_1$;

R_1 is H, F, Cl, Br, CF_2H , CCl_2H , CClFH , CF_3 or CCl_3 ;
n is an integer of 0, 1 or 2;

X is phenyl optionally substituted with one to three halogen, $\text{C}_1\text{-C}_3$ alkyl, $\text{C}_1\text{-C}_3$ alkoxy, $\text{C}_1\text{-C}_3$ alkylthio, $\text{C}_1\text{-C}_3$ alkylsulfinyl, $\text{C}_1\text{-C}_3$ alkylsulfonyl, CN, NO_2 , CF_3 , $\text{R}_2\text{CF}_2\text{B}$, R_3CO or NR_4R_5 groups;

B is S(O)_n or O;

R_2 is H, F, CF_2H , CClFH or CF_3 ;

R_3 is $\text{C}_1\text{-C}_3$ alkyl, $\text{C}_1\text{-C}_3$ alkoxy or NR_4R_5 ;

R_4 is H or $\text{C}_1\text{-C}_3$ alkyl;

R_5 is H or $\text{C}_1\text{-C}_3$ alkyl or R_6CO ;

R_6 is H or $\text{C}_1\text{-C}_3$ alkyl;

Y is H, halogen, CF_3 , CN, NO_2 , $\text{S(O)}_n\text{CF}_2\text{R}_1$ or phenyl





optionally substituted with one to three halogen,
 C_1-C_3 alkyl, C_1-C_3 alkoxy, C_1-C_3 alkylthio, C_1-C_3
 alkylsulfinyl, C_1-C_3 alkylsulfonyl, CN, NO_2 , CF_3 ,
 R_2CF_2B , R_3CO or NR_4R_5 groups;

Z is H, halogen or CF_3 ;

R is H, CN, CR_7 , $R_8CHNHCR_9$, CH_2SO ,
 C_1-C_6 alkyl optionally substituted with one to

three halogen atoms,

one tri(C_1-C_4 alkyl)silyl,

one hydroxy,

one cyano,

one or two C_1-C_4 alkoxy groups optionally
 substituted with one to three halogen
 atoms,

one C_1-C_4 alkylthio,

one phenyl optionally substituted with one to
 three halogen atoms, one to three C_1-C_4
 alkyl groups or one to three C_1-C_4
 alkoxy groups,

one phenoxy group optionally substituted with
 one to three halogen atoms, one to three
 C_1-C_4 alkyl groups or one to three C_1-C_4
 alkoxy groups,

one benzyloxy group optionally substituted on
 the phenyl ring with one to three
 halogen atoms, one to three C_1-C_4 alkyl
 groups or one to three C_1-C_4 alkoxy
 groups,

one C_1-C_6 alkylcarbonyloxy group optionally
 substituted with one to three halogen
 atoms,

one C_2-C_6 alkenylcarbonyloxy group optionally
 substituted with one to three halogen
 atoms,





one phenylcarbonyloxy group optionally substituted with one to three halogen atoms, one to three C_1-C_4 alkyl groups or one to three C_1-C_4 alkoxy groups, one C_1-C_6 alkoxy carbonyl group optionally substituted with one to three halogen atoms or one to three C_1-C_4 alkoxy groups,

one benzylcarbonyloxy group optionally substituted on the phenyl ring with one to three halogen atoms, one to three C_1-C_4 alkyl groups or one to three C_1-C_4 alkoxy groups, or

one 2-furylcarbonyloxy group,

C_3-C_6 alkenyl optionally substituted with one to three halogen atoms or one phenyl group, or

C_3-C_6 alkynyl optionally substituted with one to three halogen atoms or one phenyl group;

R_7 is C_1-C_6 alkyl or C_3-C_6 cycloalkyl each optionally substituted with

one to three halogen atoms,

one hydroxy,

one cyano,

one or two C_1-C_4 alkoxy groups optionally substituted with one to three halogen atoms,

one C_1-C_4 alkylthio,

one phenyl group optionally substituted with one to three halogen atoms, one to three C_1-C_4 alkyl groups or one to three C_1-C_4 alkoxy groups,

one phenoxy group optionally substituted with one to three halogen atoms, one to three C_1-C_4 alkyl groups or one to three C_1-C_4 alkoxy groups,





one benzyloxy group optionally substituted on the phenyl ring with one to three halogen atoms, one to three C_1-C_4 alkyl groups or one to three C_1-C_4 alkoxy groups,

one C_1-C_6 alkyl carbonyloxy group optionally substituted with one to three halogen atoms,

one C_2-C_6 alkenylcarbonyloxy group optionally substituted with one to three halogen atoms,

one phenylcarbonyloxy group optionally substituted with one to three halogen atoms, one to three C_1-C_4 alkyl groups or one to three C_1-C_4 alkoxy groups,

one C_1-C_6 alkoxycarbonyl group optionally substituted with one to three halogen atoms, or one to three C_1-C_4 alkoxy groups, or

one benzyloxycarbonyl group optionally substituted on the phenyl ring with one to three halogen atoms, one to three C_1-C_4 alkyl groups or one to three C_1-C_4 alkoxy groups,

C_2-C_6 alkenyl optionally substituted with one to three halogen atoms or one phenyl group,

C_3-C_6 alkynyl optionally substituted with one to three halogen atoms or one phenyl group,

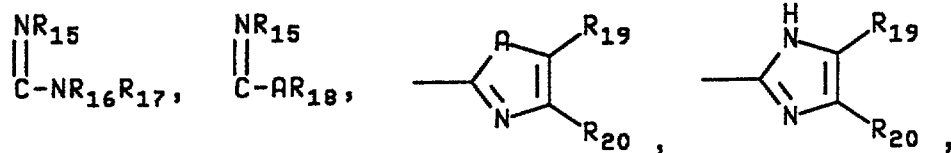
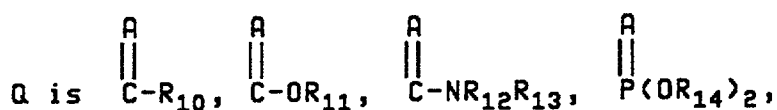
phenyl optionally substituted with one to three halogen atoms, one to three C_1-C_4 alkyl groups, one C_5-C_{12} alkyl group, one to two C_1-C_4 alkoxy groups, or one phenoxy, C_1-C_4 alkylthio, trialkylsilyl, C_1-C_4 alkylsulfinyl, C_1-C_4 alkylsulfonyl, carbo- C_1-C_4 -alkoxy, carboxy, CF_3 , CN, NO_2 , di(C_1-C_4 alkyl)amino, R_2CF_2B or C_1-C_4 alkanoylamino,

phenoxy optionally substituted with one to three halogen atoms, one or two C_1-C_4 alkyl groups, one or two C_1-C_4 alkoxy groups, trialkylsilyl, CF_3 ,





CN, NO₂, or di(C₁-C₄ alkyl)amino groups, or C₁-C₄ alkanoylamino,
 1- or 2-naphthyl,
 pyridyl, furyl, pyrrolyl or thiophenyl optionally substituted with one to three halogen atoms,
 C₁-C₆ alkoxy group optionally substituted with one to three halogen atoms; or
 C₂-C₆ alkenyloxy group optionally substituted with one to three halogen atoms;
 R₈ is hydrogen or C₁-C₄ alkyl;
 R₉ is C₁-C₆ alkyl optionally substituted with one to three halogen atoms,
 phenyl optionally substituted with one or two halogen, CN, NO₂, C₁-C₄ alkyl, C₁-C₄ alkoxy or CF₃ groups,
 2- or 3-thienyl or
 2- or 3-furyl;



CN, C₁-C₆ alkyl optionally substituted with one or more phenyl, CN or halogen groups or phenyl optionally substituted with one to three C₁-C₃ alkyl, C₁-C₃ alkoxy, halogen, CN, NO₂, CF₃ or NR₂₁R₂₂ groups;

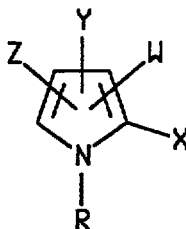
A is O or S;





- R_{10} is C_1-C_6 alkyl or phenyl;
 R_{11} is C_1-C_6 alkyl;
 R_{12} and R_{13} are each independently hydrogen, C_1-C_6 alkyl or when taken together with the atom to which they are attached may form a 5- to 7- membered ring wherein $R_{12}R_{13}$ represents from 4 to 6 hydrocarbons;
 R_{14} is C_1-C_4 alkyl;
 R_{15} is hydrogen, C_1-C_4 alkyl or may be taken together with either R_{16} or R_{18} and the atoms to which they are attached to form a 5- to 7-membered ring optionally substituted with one or two C_1-C_3 alkyl groups;
 R_{16} and R_{17} are each independently hydrogen or C_1-C_4 alkyl;
 R_{18} is C_1-C_4 alkyl or when taken together with R_{15} and the atoms to which they are attached may form a 5- to 7- membered ring optionally substituted with one or two C_1-C_3 alkyl groups;
 R_{19} and R_{20} are each independently hydrogen or C_1-C_3 alkyl or when taken together may form a ring wherein $R_{19}R_{20}$ is represented by $-C=C=C-$; and
 R_{21} and R_{22} are each independently hydrogen or C_1-C_3 alkyl.

6. The method according to claim 5 wherein the compound has the structural formula



wherein W is $S(O)_nCF_2R_1$;
X is phenyl substituted with one to three halogen, CN,



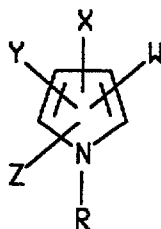


NO_2 , CF_3 or $\text{R}_2\text{CF}_2\text{B}$ groups;
Y is Cl, Br, CF_3 , CN or $\text{S}(\text{O})_n\text{CF}_2\text{R}_1$;
Z is H, Cl, Br or CF_3 ;

O
||
R is H, CN, CR_7 or $\text{C}_1\text{-C}_4$ alkyl optionally substituted with one to three halogen atoms, one $\text{C}_1\text{-C}_4$ alkoxy group, one cyano, one $\text{C}_1\text{-C}_6$ alkylcarbonyloxy group, one phenylcarbonyloxy group optionally substituted with one to three halogen atoms or one $\text{C}_1\text{-C}_4$ alkyl group, one benzylcarbonyloxy group or one 2-furylcarbonyloxy group; and

R_7 is phenyl optionally substituted with one to three halogen atoms, one or two $\text{C}_1\text{-C}_4$ alkyl groups, one or two $\text{C}_1\text{-C}_4$ alkoxy groups, CF_3 , CN, NO_2 or $\text{R}_2\text{CF}_2\text{B}$.

7. A method for protecting growing plants from attack by insects and acarina which comprises applying to the foliage of said plants or to the soil or water in which they are growing an insecticidally or acaricidally effective amount of a compound having the structural formula



wherein W, X, Y, Z and R are as described in claim 5.

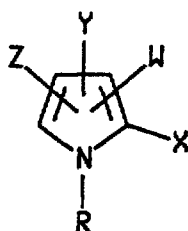
8. The method according to claim 7 wherein the compound has the structural formula



This Sheet Has Been Replaced

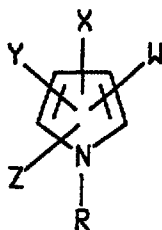


- 107 -



wherein X, W, Y, Z and R are as described in claim 14.

9. A composition for controlling insects and acarina comprising an agronomically acceptable carrier and an insecticidally or acaricidally effective amount of a compound having the structural formula



wherein W, X, Y, Z and R are as described in claim 1.

10. The composition according to claim 9 wherein the compound is as described in claim 2.

