

**WHO SPECIFICATIONS AND EVALUATIONS
FOR PUBLIC HEALTH PESTICIDES**

DIFLUBENZURON

1-(4-chlorophenyl)-3-(2,6-difluorobenzoyl)urea



**World Health
Organization**

TABLE OF CONTENTS

DIFLUBENZURON

	Page	
DISCLAIMER	3	
INTRODUCTION	4	
 PART ONE		
SPECIFICATIONS FOR DIFLUBENZURON		
DIFLUBENZURON INFORMATION	6	
DIFLUBENZURON TECHNICAL CONCENTRATE (APRIL 2005)	7	
DIFLUBENZURON WETTABLE POWDER (APRIL 2005)	8	
DIFLUBENZURON GRANULES (FEBRUARY 2006)	10	
DIFLUBENZURON TABLETS FOR DIRECT APPLICATION (FEBRUARY 2006)	12	
 PART TWO		
EVALUATIONS OF DIFLUBENZURON		
2004	FAO/WHO EVALUATION REPORT ON DIFLUBENZURON	15

Disclaimer¹

WHO specifications are developed with the basic objective of promoting, as far as practicable, the manufacture, distribution and use of pesticides that meet basic quality requirements.

Compliance with the specifications does not constitute an endorsement or warranty of the fitness of a particular pesticide for a particular purpose, including its suitability for the control of any given pest, or its suitability for use in a particular area. Owing to the complexity of the problems involved, the suitability of pesticides for a particular purpose and the content of the labelling instructions must be decided at the national or provincial level.

Furthermore, pesticides which are manufactured to comply with these specifications are not exempted from any safety regulation or other legal or administrative provision applicable to their manufacture, sale, transportation, storage, handling, preparation and/or use.

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Additionally, WHO wishes to alert users to the fact that improper storage, handling, preparation and/or use of pesticides can result in either a lowering or complete loss of safety and/or efficacy.

WHO is not responsible, and does not accept any liability, for the testing of pesticides for compliance with the specifications, nor for any methods recommended and/or used for testing compliance. As a result, WHO does not in any way warrant or represent that any pesticide claimed to comply with a WHO specification actually does so.

¹ This disclaimer applies to all specifications published by WHO.

INTRODUCTION

WHO establishes and publishes specifications* for technical material and related formulations of public health pesticides with the objective that these specifications may be used to provide an international point of reference against which products can be judged either for regulatory purposes or in commercial dealings.

From 2002, the development of WHO specifications follows the **New Procedure**, described in the 1st edition of Manual for Development and Use of FAO and WHO Specifications for Pesticides (2002). This **New Procedure** follows a formal and transparent evaluation process. It describes the minimum data package, the procedure and evaluation applied by WHO and the experts of the “FAO/WHO Joint Meeting on Pesticide Specifications” (JMPS).

WHO Specifications now only apply to products for which the technical materials have been evaluated. Consequently, from the year 2002 onwards the publication of WHO specifications under the **New Procedure** has changed. Every specification consists now of two parts, namely the specifications and the evaluation report(s):

Part One: The Specification of the technical material and the related formulations of the pesticide in accordance with chapters 4 to 9 of the 1st edition of the “FAO/WHO Manual on Pesticide Specifications.”

Part Two: The Evaluation Report(s) of the pesticide, reflecting the evaluation of the data package carried out by WHO and the JMPS. The data are provided by the manufacturer(s) according to the requirements of chapter 3 of the “FAO/WHO Manual on Pesticide Specifications” and supported by other information sources. The Evaluation Report includes the name(s) of the manufacturer(s) whose technical material has been evaluated. Evaluation reports on specifications developed subsequently to the original set of specifications are added in a chronological order to this report.

WHO specifications under the **New Procedure** do not necessarily apply to nominally similar products of other manufacturer(s), nor to those where the active ingredient is produced by other routes of manufacture. WHO has the possibility to extend the scope of the specifications to similar products but only when the JMPS has been satisfied that the additional products are equivalent to that which formed the basis of the reference specification.

Specifications bear the date (month and year) of publication of the current version. Dates of publication of the earlier versions, if any, are identified in a footnote. Evaluations bear the date (year) of the meeting at which the recommendations were made by the JMPS.

* Footnote: The publications are available on the Internet under (<http://www.who.int/quality/en/>).

PART ONE
SPECIFICATIONS

DIFLUBENZURON

	Page
DIFLUBENZURON INFORMATION	6
DIFLUBENZURON TECHNICAL CONCENTRATE (APRIL 2005)	7
DIFLUBENZURON WETTABLE POWDER (APRIL 2005)	8
DIFLUBENZURON GRANULES (FEBRUARY 2006)	10
DIFLUBENZURON TABLETS FOR DIRECT APPLICATION (FEBRUARY 2006)	12

WHO SPECIFICATIONS FOR PUBLIC HEALTH PESTICIDES

DIFLUBENZURON

INFORMATION

ISO common name

Diflubenzuron (E-ISO, (m) F-ISO, ANSI, ESA)

Chemical names

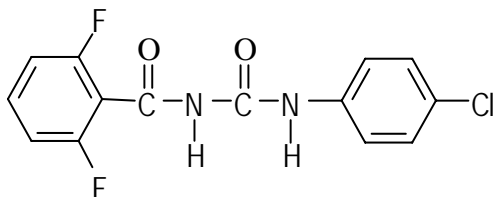
IUPAC: 1-(4-chlorophenyl)-3-(2,6-difluorobenzoyl)urea

CAS: N-[[4-chlorophenyl]amino]carbonyl]-2,6-difluorobenzamide

Synonyms

Dimilin, Micromite, Adept, DU 112307, PH 60-40, TH 6040, ENT-29054, OMS 1804 (Crompton trade names and/or past development codes).

Structural formula



Molecular formula

$C_{14}H_9ClF_2N_2O_2$

Relative molecular mass

310.7

CAS Registry number

35367-38-5

CIPAC number

339

Identity tests

HPLC retention time; IR spectrum

DIFLUBENZURON TECHNICAL CONCENTRATE

WHO specification 339/TK (April 2005*)

This specification, which is PART ONE of this publication, is based on an evaluation of data submitted by the manufacturer whose name is listed in the evaluation report (339/2004). It should be applicable to relevant products of these manufacturers but it is not an endorsement of those products, nor a guarantee that they comply with the specifications. The specification may not be appropriate for the products of other manufacturers. The evaluation report (339/2004) as PART TWO forms an integral part of this publication.

1 Description

The material shall consist of diflubenzuron, together with related manufacturing impurities, and shall be an off-white, fine powder, free from visible extraneous matter and added modifying agents except for the diluent.

2 Active ingredient

2.1 Identity tests (CIPAC method 339/TK/M/2, Handbook H, p.141, 1998)

The active ingredient shall comply with an identity test and, where the identity remains in doubt, shall comply with at least one additional test.

2.2 Diflubenzuron content (CIPAC method 339/TK/M/3, Handbook H, pp.141-144, 1998)

The diflubenzuron content shall be declared (not less than 900 g/kg) and, when determined, the average measured content shall not differ from that declared by more than ± 25 g/kg.

3 Physical properties

3.1 Particle size (MT 187, CIPAC Handbook K, p.153, 2003) (Note 1)

Particles smaller than 5 μm : not less than 70% w/w.

Average particle size: not more than 3.75 μm .

Note 1 Control of particle size is required to ensure efficacy of the formulated products.

* Specifications may be revised and/or additional evaluations may be undertaken. Ensure the use of current versions by checking at: <http://www.who.int/quality/en/>.

DIFLUBENZURON WETTABLE POWDER

WHO specification 339/WP (April 2005*)

This specification, which is PART ONE of this publication, is based on an evaluation of data submitted by the manufacturer whose name is listed in the evaluation report (339/2004). It should be applicable to relevant products of these manufacturers but it is not an endorsement of those products, nor a guarantee that they comply with the specifications. The specification may not be appropriate for the products of other manufacturers. The evaluation report (339/2004) as PART TWO forms an integral part of this publication.

1 Description

The material shall consist of an homogeneous mixture of technical diflubenzuron, complying with the requirements of WHO specification 339/TK (April 2005), together with filler(s) and any other necessary formulants. It shall be in the form of a fine, white to yellowish-brown powder, free from visible extraneous matter and hard lumps.

2 Active ingredient

2.1 Identity tests (CIPAC method 339/WP/M/2, Handbook H, p 145, 1998)

The active ingredient shall comply with an identity test and, where the identity remains in doubt, shall comply with at least one additional test.

2.2 Diflubenzuron content (CIPAC method 339/WP/M/3, Handbook H, pp.145-146, 1998)

The diflubenzuron content shall be declared (g/kg) and, when determined, the average measured content shall not differ from that declared by more than the following tolerance:

Declared content, g/kg	Tolerance
above 100 up to 250	± 6% of the declared content

Note: the upper limit is included in the range

3 Physical properties

3.1 Wet sieve test (MT 59.3, CIPAC Handbook F, p.179, 1995)

Maximum: 1% retained on a 75 µm test sieve.

3.2 Suspensibility (MT 184, CIPAC Handbook K, p.142, 2003) (Notes 1 & 2)

A minimum of 60% of the diflubenzuron content found under 2.2 shall be in suspension after 30 min in CIPAC Standard Water D at 30 ± 2°C (Note 3).

3.3 Persistent foam (MT 47.2, CIPAC Handbook F, p.152, 1995) (Note 4)

Maximum: 50 ml after 1 min.

* Specifications may be revised and/or additional evaluations may be undertaken. Ensure the use of current versions by checking at: <http://www.who.int/quality/en/>.

3.4 **Wettability** (MT 53.3, CIPAC Handbook F, p.164, 1995)

The formulation shall be completely wetted in 2 min without swirling.

4 **Storage stability**

4.1 **Stability at elevated temperature** (MT 46.3, CIPAC Handbook J, p.128, 2000)

After storage at $54 \pm 2^\circ\text{C}$ for 14 days, the determined average active ingredient content must not be lower than 95% relative to the determined mean content found before storage (Note 5) and the formulation shall continue to comply with the clauses for:

- wet sieve test (3.1);
- suspensibility (3.2);
- wettability (3.4).

Note 1 The formulation should be tested at the highest and lowest rates of use recommended by the supplier, provided this does not exceed the conditions given in method MT 15.1.

Note 2 This test will normally only be carried out after the heat stability test, 4.1.

Note 3 Chemical assay is the only fully reliable method to measure the mass of active ingredient still in suspension. However, the simpler gravimetric method, MT 168, may be used on a routine basis provided that it has been shown to give equal results to those of chemical assay. In case of dispute, chemical assay shall be the "referee method".

Note 4 The mass of sample to be used in the test should be at the highest rate of use recommended by the supplier.

Note 5 Samples of the formulation taken before and after the storage stability test should be analyzed concurrently after the test in order to reduce the analytical error.

DIFLUBENZURON GRANULES (Note 1)

WHO specification 339/GR (February 2006*)

This specification, which is PART ONE of this publication, is based on an evaluation of data submitted by the manufacturer whose name is listed in the evaluation report (339/2004). It should be applicable to relevant products of these manufacturers but it is not an endorsement of those products, nor a guarantee that they comply with the specifications. The specification may not be appropriate for the products of other manufacturers. The evaluation report (339/2004) as PART TWO forms an integral part of this publication.

1 Description

The material shall consist of creamy-grey granules containing technical diflubenzuron, complying with the requirements of WHO specification 339/TK (April 2005), together with suitable carriers and any other necessary formulants. It shall be dry, free from visible extraneous matter and hard lumps, free-flowing, essentially non-dusty and intended for application manually or by machine.

2 Active ingredient

2.1 Identity tests (CIPAC method 339/GR/M/2, Handbook H, pp 141-146, 1998, Note 2)

The active ingredient(s) shall comply with an identity test and, where the identity remains in doubt, shall comply with at least one additional test.

2.2 Diflubenzuron content (CIPAC method 339/GR, Handbook H, pp 141-146, 1998, Note 2)

The diflubenzuron content shall be declared (20 g/kg) and, when determined, the average content measured shall not differ from that declared by more than $\pm 25\%$.

3 Relevant impurities (Note 1)

3.1 Water (MT 30.5, CIPAC Handbook J, p.120, 2000)

Maximum: 20 g/kg.

4 Physical properties

4.1 Acidity (MT 191, Note 3) (Notes 1 & 3)

Maximum acidity: 500 g/kg calculated as H₂SO₄.

* Specifications may be revised and/or additional evaluations may be undertaken. Ensure the use of current versions by checking at: <http://www.who.int/quality/en/>.

4.2 **Pour and tap density** (MT 186, CIPAC Handbook K, p.151, 2003)

Pour density: 0.80 to 0.90 g/ml.

Tap density: 0.85 to 0.95 g/ml.

4.3 **Nominal size range** (MT 58, CIPAC Handbook F, p.173, 1995)

Nominal size range: 500 to 2000 µm. Not less than 850 g/kg of the formulation shall be within the nominal size range.

4.4 **Dustiness** (MT 171, CIPAC Handbook F, p.425, 1995, Note 4)

Nearly dust free.

4.5 **Attrition resistance** (MT178, CIPAC Handbook H, p.304, 1998)

Minimum: 95% attrition resistance.

5 **Storage stability**

5.1 **Stability at elevated temperature** (MT 46.3, CIPAC Handbook J, p.128, 2000)

After storage at $54 \pm 2^\circ\text{C}$ for 14 days the determined average active ingredient content must not be lower than 95%, relative to the determined average content found before storage (Note 5), and the formulation shall continue to comply with the clauses for:

- acidity (4.1),
- pour and tap density (4.2),
- nominal size range (4.3),
- dustiness (4.4),
- attrition resistance (4.5)

Note 1 The specification does not include encapsulated granules (CG), microgranules (MG), or macrogranules (GG). The granules contain a water-soluble acid carrier and an effervescent system, so the water content must be kept low prior to application. The granules are not intended for dispersion in water prior to application.

Note 2 The method for determination of diflubenzuron, published in CIPAC Handbook H was validated for analysis of TK and WP. Extension of the method to GR was validated and adopted by CIPAC in 2005 but the details are not yet published in a Handbook. Prior to publication of the Handbook, details may be obtained through the CIPAC website, <http://www.cipac.org/prepubme.htm> or from the CIPAC Secretary, Dr László Bura (mail to bura.laszlo@ntks.ontsz.hu).

Note 3 MT 191 was adopted by CIPAC in 2004 but the details are not yet published in a Handbook. Prior to publication of the Handbook, details may be obtained through the CIPAC website, <http://www.cipac.org/prepubme.htm> or from the CIPAC Secretary, Dr László Bura (mail to bura.laszlo@ntks.ontsz.hu).

Note 4 The optical method, MT 171.2, usually shows good correlation with the gravimetric method, MT 171.1, and can, therefore, be used as an alternative where the equipment is available. Where the correlation is in doubt, it must be checked with the formulation to be tested. In cases of dispute, the gravimetric method shall be used.

Note 5 Samples of the formulation taken before and after the storage stability test should be analyzed concurrently after the test in order to reduce the analytical error.

DIFLUBENZURON TABLETS FOR DIRECT APPLICATION (Note 1)

WHO specification 339/DT (February 2006*)

This specification, which is PART ONE of this publication, is based on an evaluation of data submitted by the manufacturer whose name is listed in the evaluation report (339/2004). It should be applicable to relevant products of these manufacturers but it is not an endorsement of those products, nor a guarantee that they comply with the specifications. The specification may not be appropriate for the products of other manufacturers. The evaluation report (339/2004) as PART TWO forms an integral part of this publication.

1 Description

The material shall consist of an homogeneous mixture of technical diflubenzuron, complying with the requirements of WHO specification 339/TK (April 2005), together with carriers and any other necessary formulants. It shall be in the form of tablets for direct application. The formulation shall be of dry, unbroken, free-flowing tablets, free from visible extraneous matter.

2 Active ingredient

2.1 Identity tests (CIPAC method 339, Handbook H, pp 141-146, 1998, Notes 2 & 3)

The active ingredient shall comply with an identity test and, where the identity remains in doubt, shall comply with at least one additional test.

2.2 Diflubenzuron content (CIPAC method 339, Handbook H, pp 141-146, 1998, Notes 2 & 3)

The diflubenzuron content shall be declared (20 g/kg) and, when determined, the average content measured shall not differ from that declared by more than $\pm 25\%$.

3 Relevant impurities (Notes 1 & 2)

3.1 Water (MT 30.5, CIPAC Handbook J, p.120, 2000)

Maximum: 40 g/kg.

4 Physical properties

4.1 Acidity (MT 191, Notes 2 & 4)

Maximum acidity: 150 g/kg calculated as H₂SO₄.

4.2 Tablet integrity (Notes 2 & 5)

No broken tablets.

* Specifications may be revised and/or additional evaluations may be undertaken. Ensure the use of current versions by checking at: <http://www.who.int/quality/en/>.

4.3 Degree of attrition (MT 193, Notes 2 & 6)

Maximum attrition: 2% (loose-packed tablets).

Maximum attrition: 1% (close-packed tablets).

5 Storage stability

5.1 Stability at elevated temperature (MT 46.3, CIPAC Handbook J, p.128, 2000) (Note 2)

After storage at $54 \pm 2^\circ\text{C}$ for 14 days without pressure (Note 7), the determined average active ingredient content must not be lower than 95%, relative to the determined average content found before storage (Note 8), and the formulation shall continue to comply with the clauses for:

- acidity (4.1),
- tablet integrity (4.2, Note 5),
- degree of attrition (4.3).

Note 1 The tablets contain an effervescent system with its water-soluble acid component present in excess, a combination intended to aid gentle dispersion in water after application. The tablets are not intended for dispersion in water prior to application.

Note 2 Sub-samples for analysis (2.1, 2.2, 3.1, 4.1) are prepared as follows.
An appropriate quantity of tablets should be milled to a powder and thoroughly mixed, prior to withdrawing test portions for analysis.

Sub-samples for tests of other physical properties and storage stability are prepared as follows.

To determine degree of attrition (4.3, MT 193), or storage stability (5.1, MT 46.3), tablets must not be broken prior to the test. To determine tablet integrity (4.2), before or after the test of storage stability, at least one pack/package of multiple tablets must be examined.

Note 3 The method for determination of diflubenzuron, published in CIPAC Handbook H was validated for analysis of TK and WP. Extension of the method to tablets was validated and adopted by CIPAC in 2005 but the details are not yet published in a Handbook. Prior to publication of the Handbook, details may be obtained through the CIPAC website, <http://www.cipac.org/prepubme.htm> or from the CIPAC Secretary, Dr László Bura (mail to bura.laszlo@ntkpsz.ontsz.hu).

Note 4 MT 191 was adopted by CIPAC in 2004 but the details are not yet published in a Handbook. Prior to publication of the Handbook, details may be obtained through the CIPAC website, <http://www.cipac.org/prepubme.htm> or from the CIPAC Secretary, Dr László Bura (mail to bura.laszlo@ntkpsz.ontsz.hu).

Note 5 By visual examination.

Note 6 CIPAC MT 193 is described as a test of friability (the tendency to crumble) but it measures attrition (the tendency to lose material from surfaces/edges as a result of impact and friction). The method was adopted by CIPAC in 2004 but the details are not yet published in a Handbook. Prior to publication of the Handbook, details may be obtained through the CIPAC website, <http://www.cipac.org/prepubme.htm> or from the CIPAC Secretary, Dr László Bura (mail to bura.laszlo@ntkpsz.ontsz.hu).

Note 7 Without pressure means that the test is done as specified by method MT 46.3, but no pressure is applied to the sample during its ageing.

Note 8 Analysis of the formulation before and after the storage stability test, should be carried out concurrently (i.e. after storage) to minimize the analytical error.

PART TWO

EVALUATION REPORTS

DIFLUBENZURON

		Page
2004	FAO/WHO evaluation report based on submission of information from Crompton Europe B.V. (TK, GR, WP, DT, SC)	15

WHO SPECIFICATIONS FOR PUBLIC HEALTH PESTICIDES

DIFLUBENZURON FAO/WHO EVALUATION REPORT 339/2004

Explanation

The data for diflubenzuron were evaluated in support of review of existing WHO specifications, WHO/SIT/25.R1 for diflubenzuron technical concentrate (TK) and WHO/SIF/47.R1 for diflubenzuron wettable powder (WP), as developed by WHOPES following the old procedure and revised on 10 December 1999. New specifications were proposed for diflubenzuron granules (GR) and tablets for direct application (DT) in public health and for suspension concentrates (SC) for use in agriculture.

Diflubenzuron is not under patent.

Diflubenzuron was evaluated by the FAO/WHO JMPR and WHO/IPCS in 1981, 1984, 1988 and 2002. The US EPA published a Re-registration Eligibility Decision for diflubenzuron in August 1997. Diflubenzuron is currently under review by the European Commission under Directive 91/414/EC. Crompton Europe B.V. has notified diflubenzuron as an existing biocidal active ingredient under the Biocidal Products Directive 98/8/EC.

The draft specification and the supporting data were provided by Crompton Europe B.V. in October 2003 and February 2004.

Uses

Diflubenzuron is an insect growth regulator, used in agriculture, horticulture and forestry against larvae of Lepidoptera, Coleoptera, Diptera, Hymenoptera and in public health against larvae of mosquitoes and other noxious insects.

Identity

ISO common name

Diflubenzuron (E-ISO, (m) F-ISO, ANSI, ESA)

Chemical names

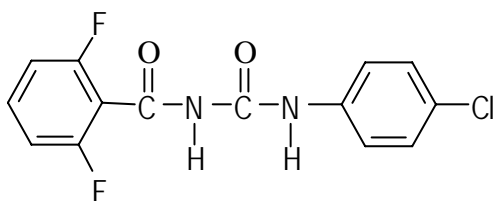
IUPAC: 1-(4-chlorophenyl)-3-(2,6-difluorobenzoyl)urea

CAS: *N*-[[4-chlorophenyl]amino]carbonyl]-2,6-difluorobenzamide

Synonyms

Dimilin, Micromite, Adept, Du-Dim, Device, DU 112307, PH 60-40, TH 6040, ENT-29054, OMS 1804 (Crompton trade names and/or past development codes).

Structural formula



Molecular formula



Relative molecular mass

310.7

CAS Registry number

35367-38-5

CIPAC number

339

Identity tests

HPLC retention time; IR spectrum.

Physical and chemical properties

Table 1. Physicochemical properties of pure diflubenuron

Characteristic	Value	Purity, %	Method	Reference
Vapour pressure	$\leq 1.2 \times 10^{-7}$ Pa at 25°C	>99.5	OECD guideline 104	DI 7081
Melting point, boiling point and/or temperature of decomposition	Melting point: 228°C Boiling point: Not required, because diflubenuron is neither a liquid, nor a low melting substance Decomposition temperature: no decomposition at melting point	99.9	OECD guideline 102	DI 9321 DI 11496 DI 9321
Solubility in water	0.08 mg/l at 25°C at pH 7 0.10 mg/l at pH 4 0.32 mg/l at pH 10	>99.5	EEC guideline A6	DI 7233 DI 9167
Octanol/water partition coefficient	Log P_{ow} = 3.89 at 22°C at pH 3	99.9	EEC guideline A8	DI 7016
Hydrolysis characteristics	Half-life > 180 days at 25°C at pH 5 and 7 Half-life = 32.5 days at 25°C at pH 9	97.1	EPA guideline CG5000	DI 6799
Photolysis characteristics	The estimated half-life of diflubenuron in natural sunlight at latitude 40° N is 80 days at 25°C (from 40 days continuous irradiation with a 450 W Xenon arc lamp)	97.1	EPA guideline CG6000	DI 6799 DI 6689
Dissociation characteristics	Does not dissociate	99.9	OECD guideline 112	DI 11387

Table 2. Chemical composition and properties of diflubenzuron technical concentrate (TK)

Manufacturing process, maximum limits for impurities ≥ 1 g/kg, 5 batch analysis data.	Confidential information supplied and held on file by FAO. Mass balances were 99.0-100.3%.
Declared minimum diflubenzuron content:	875 g/kg
Relevant impurities ≥ 1 g/kg and maximum limits for them:	None *
Relevant impurities < 1 g/kg and maximum limits for them:	None
Stabilizers or other additives and maximum limits for them:	None
Melting or boiling temperature range	228°C, no decomposition at melting point.
Particle size	Particles smaller than 5 μm : not less than 70% w/w. Average particle size: not more than 3.75 μm .

* Water is a relevant impurity in GR (20 g/kg) and DT (40 g/kg), because these formulations contain effervescent systems.

Hazard summary

Notes.

(i) The proposers provided written confirmation that the toxicological and ecotoxicological data included in the summary below were derived from diflubenzuron having impurity profiles similar to those referred to in the table above.

(ii) The conclusions expressed in the summary below are those of the proposers, unless otherwise specified.

(iii) The acute toxicity data relate to studies with diflubenzuron TC and/or with diflubenzuron VC-90, a TK containing 90% diflubenzuron, which has the same toxicological profile as the active ingredient itself.

Table 3. Toxicology profile of technical diflubenzuron, based on acute toxicity, irritation and sensitization

Species	Test	Duration and conditions	Result	Reference
Rat (male and female)	Oral	OECD guideline 401, purity 90%	LD ₅₀ >5000 mg/kg bw	DI 4959
Rat, mouse (male and female)	Oral (gavage)	Guideline not stated, purity 99.6%	LD ₅₀ >4640 mg/kg bw	DI 2207
Mouse (male and female)	Oral (gavage)	Guideline not stated, purity 99.6%	LD ₅₀ >4640 mg/kg bw	DI 2203
Rat (male and female)	Dermal	OECD guideline 402, purity 90%	LD ₅₀ >2000 mg/kg bw	DI 4958
Rat	Dermal	24 hours. PSD, UK (1971) purity 99.6%	LD ₅₀ >10000 mg/kg bw	DI 2227
Rat (male and female)	Inhalation	OECD guideline 403 purity 90%	LC ₅₀ >2490 mg/m ³	DI 5710
Rat	Inhalation	Guideline not stated, purity 99.6%	LC ₅₀ >2900 mg/m ³	DI 3513
Rabbit (male and female)	Skin irritation	OECD guideline 404, purity 90%	Non-irritant	DI 4961

Species	Test	Duration and conditions	Result	Reference
Rabbit (male and female)	Eye irritation	OECD guideline 405, purity 90%	Slightly irritating (Note 1)	DI 4960
Guinea pig	Skin sensitization	OECD guideline 406, purity 95.6%	Non-sensitizer	DI 8423

Note 1: Although a slight reaction was observed during the eye irritation tests, the findings did not trigger classification of diflubenzuron as an eye irritant.

Table 4. Toxicology profile of technical diflubenzuron based on repeated administration (sub-acute to chronic)

Species	Test	Duration and conditions	Result	Reference
Mouse	Oral 6-week	No guideline specified, Dose range tested: 0; 16 & 50 ppm; purity 99.6%	NOAEL = 2.0 mg/kg bw/day (16 ppm)	DI 3523
Mouse	Oral 90-day	No guideline specified, Dose range tested: 0; 16; 50; 400; 2,000; 10,000 & 50,000 ppm; purity 97.2%	NOAEL = 7.1 mg/kg bw/day (50 ppm)	DI 2212 DI 3522
Mouse	Oral 14-week	No guideline specified, Dose range tested: 0; 80; 400; 2000; 10,000 & 50,000 ppm; purity 97.2%	NOAEL = 10.4 mg/kg bw/day (80 ppm)	DI 4155
Rat	Oral 28-day	No guideline specified, dose range tested: 0; 800; 4,000; 20,000 & 100,000 ppm; purity 98.5%.	LOEL = 84 mg/kg bw/day (800 ppm)	DI 4161
Rat	Oral 90-day	No guideline specified, dose range tested: 0; 3.125; 12.5; 50 & 200 ppm; purity 96.0%.	NOAEL = 21.6 mg/kg bw/day (200 ppm)	DI 2376 DI 3528
Rat	Oral 90-day	No guideline specified, Dose range tested: 0; 160; 400; 2,000; 10,000 & 50,000 ppm; purity 96.0%	NOAEL = 12.6 mg/kg bw/day (160 ppm)	DI 2168 DI 4279
Rat	Oral 9-week	No guideline specified; Dose range tested: 0; 10,000 & 100,000 ppm; purity 98.5%	LOEL = 1000 mg/kg bw/day (10,000 ppm)	DI 3517
Dog	Oral 90-day	No guideline specified, Dose range tested: 0; 10; 20; 40 & 160 ppm; purity 99.6%	NOAEL = 0.84 mg/kg bw/day (20 ppm)	DI 2375
Dog	Oral 90-day	No guideline specified, Dose range tested: 0; 2; 4; 50 & 250 mg/kg bw/day; purity 97.6%	NOAEL = 4 mg/kg b.w./day	DI 987
Dog	Oral 1-year	No guideline specified, Dose range tested: 0; 2; 10; 50 & 500 mg/kg b.w./day; purity 97.6%	NOAEL = 2 mg/kg b.w./day	DI 4852

Species	Test	Duration and conditions	Result	Reference
Rat	Inhalation 28-day (1 hr/day)	No guideline specified, Dose range tested: 0; 0.5/0.12; 5.0/0.87 & 50/1.85 mg/L (nominal/actual); purity: 99.6%	NOAEL = 0.12 mg/L (actual)	DI 2359
Rabbit	Inhalation 21-day (1 hr/day)	No guideline specified, Dose range tested: 0; 0.5/0.15; 5.0/0.75; 25/1.79 mg/L (nominal/actual); purity 99.6%	NOAEL = 0.15 mg/L (actual)	DI 2360
Rat	Inhalation 28-day (6 hr/day)	OECD Guideline 412; Dose range tested: 0; 10/12; 30/34 & 100/109 mg/m ³ (nominal/actual); purity 96.5%	NOAEL = 34 mg/m ³ (actual)	DI 11497
Rabbit	Percutaneous 21-day	No guideline specified, Dose range tested: 0; 69.6; 150 & 322.5 mg/kg/day; purity 99.6%	NOAEL = 150 mg/kg/day	DI 2216
Rabbit	Percutaneous 21-day	No guideline specified, Dose range tested: 0; 113 & 345 mg/kg/day; purity 99.6%	Not established	DI 2217
Rat	Percutaneous 21-day	Guideline US EPA FIFRA vol 43, no 163, Dose range tested: 0; 20; 500 & 1,000 mg/kg/day; purity 96.7%	NOAEL = 20 mg/kg/day	DI 9429
Rat	104 weeks dietary carcinogenicity	No guideline specified; Dose range tested: 0; 10; 20; 40; and 160 ppm; purity 99.6%	NOAEL = 1.43 mg/kg bw (males) and 1.73 mg/kg bw (females) (40 ppm) Not carcinogenic	DI 4037
Rat	104 weeks dietary carcinogenicity	Guideline US EPA FIFRA vol. 43 no. 163; Dose range tested: 0; 156; 625; 2,500 and 10,000 ppm; purity 97.6%	LOAEL = 7.8 mg/kg bw/day (156 ppm) Not carcinogenic	DI 8147
Mouse	80 weeks dietary carcinogenicity	No guideline specified; Dose range tested: 0; 4; 8; 16 and 50 ppm; purity: 99.6%	> 7.4 mg/kg bw/day (> 50 ppm) Not carcinogenic	DI 3525
Mouse	91 weeks dietary carcinogenicity	No guideline specified; Dose range tested: 0; 16; 80; 400; 2,000 and 10,000 ppm; purity 97.6%.	NOAEL = 2.4 mg/kg bw/day (16 ppm) Not carcinogenic	DI 8146
Rat	3-generation parental and reproduction toxicity	No guideline specified; Dose range tested: 0; 10, 20, 40 and 160 ppm; purity 99.6%	NOAEL = 8 mg/kg bw/day (160 ppm)	DI 3516

Species	Test	Duration and conditions	Result	Reference
Rat	1-generation reproduction toxicity	No guideline specified; Dose range tested: 0, 1000 and 100000 ppm; purity 98.5%	NOAEL = 50 mg/kg bw/day (1000 ppm)	DI 3462
Rat	2-generation reproduction toxicity	OECD guideline 416; Dose range tested: 0, 500, 5000 and 50000 ppm; purity 97.1%	NOAEL for reproductive function = 2500 mg/kg bw/day (50000 ppm)	DI 9182
Rat	Teratogenicity (gavage)	No guideline specified; Dose range tested: 0, 1,2 and 4 mg/kg bw during days 6-15 of gestation; purity 98.5%	Pregnancy rates were unaffected	DI 2349
Rat	Teratogenicity (gavage)	US EPA guideline 83-3 subdivision F; Dose range tested: 0 and 1000 mg/kg bw during days 6-15 of gestation; purity 98.5%	No maternal or embryotoxicity at 1000 mg/kg bw/day	DI 6552
Rabbit	Teratogenicity (gavage)	No guideline specified; Dose range tested: 0, 1,2 and 4 mg/kg bw during days 6-19 of gestation; purity 98.5%	Pregnancy rates were unaffected	DI 2350
Rabbit	Teratogenicity (gavage)	US EPA guideline 83-3 subdivision F; Dose range tested: 0 and 1000 mg/kg bw during days 7-19 of pregnancy; purity 98.5%	NOAEL for maternal and embryotoxicity = 1000 mg/kg bw/day	DI 6553

a Highest dose tested.

b Lowest dose tested.

Table 5. Mutagenicity profile of technical diflubenzuron based on *in vitro* and *in vivo* tests.

Species	Test	Conditions	Result	Reference
<i>Salmonella typhimurium</i>	<i>In vitro</i> genotoxicity test	OECD guideline 471, purity 96.9%	Negative	DI 7988
<i>Saccharomyces cerevisiae</i>	<i>In vitro</i> genotoxicity test	OECD guideline 471, purity 98.5%	Negative	DI 2261
BALB/3T3 cells	<i>In vitro</i> genotoxicity test	OECD guideline 471, purity 98.5%	Negative	DI 2263
CHO cells	<i>In vitro</i> genotoxicity test	OECD guideline 473, purity 97.6%	Negative	DI 5707
Rat hepatocytes	<i>In vivo</i> genotoxicity test	OECD guideline 482, purity 96.9%	Negative	DI 7987
WI-38	<i>In vivo</i> genotoxicity test	OECD guideline 486, purity 98.5%	Negative	DI 2264
Mouse germ cells	Dominant lethal study in mice. <i>In vivo</i> genotoxicity test	Guideline not stated, purity not stated	Negative	DI 2348

Table 6. Ecotoxicology profile of diflubenzuron technical concentrate

Species	Test	Duration and conditions	Result	Reference
<i>Daphnia magna</i>	Acute toxicity	48 hr, 20°C, Guideline ASTM E729-80, purity 97.6%	EC ₅₀ = 2.6-7.1 µg/l NOEC 0.45 µg/l	DI 6773
<i>Daphnia magna</i>	Acute toxicity	48 hr, 20°C OECD Guideline 202, purity 79.4% (WG, Note 1)	EC ₅₀ = 3.2 µg WG-80/l NOEC = 0.38 µg WG-80/l	DI 9180
Zebra fish (<i>Brachydanio rerio</i>)	Acute toxicity	96 hr, 22°C OECD Guideline 203, purity 95.6%	LC ₅₀ >0.2 mg/l	DI 8925
Minnow (<i>Cyprinodon variegates</i>)	Acute toxicity	96 hr, 22°C Guideline US EPA 40 CFR 158.145 72-3, purity 100% (Note 1)	LC ₅₀ >130 µg/l	DI 6152
Zebra fish (<i>Brachydanio rerio</i>)	Acute toxicity	96 hr, 22°C OECD Guideline 203, purity 79.4% (WG, Note 1)	LC ₅₀ >106 mg a.i./l	DI 8929
Minnow (<i>Cyprinodon variegates</i>)	Acute toxicity	96 hr, 22°C Guideline US EPA FIFRA Subdivision E 72-3 and OECD 203, purity 95.6%	LC ₅₀ >130 µg a.i./l	DI 8668
Rainbow trout (<i>Oncorhynchus mykiss</i>)	Acute toxicity	96 hr, 15°C Guideline OECD 203, purity 95.6% but WG 80 formulation used purity 79.4% (Note 1)	LC ₅₀ >65 mg/l	DI 8926
Rainbow trout (<i>Oncorhynchus mykiss</i>)	Acute toxicity	96 hr, 15°C Guideline OECD 203, purity 79.4% (Note 1)	LC ₅₀ >106 mg a.i./l	DI 8927
<i>Selenastrum capricornutum</i> (green alga)	Growth rate test	5 days, 22°C Guideline US EPA FIFRA Subdivision J, Series 123-2, purity 95.6% ^d but WG formulation used (Note 1)	EC ₅₀ >80 mg a.i./l NOEC = 80 mg a.i./l	DI 8667
<i>Selenastrum capricornutum</i> (green alga)	Acute toxicity	OECD guideline 201, purity 79.4%	EC ₅₀ >80 mg a.i./l NOEC = 80 mg a.i./l	DI 9104
Earthworm (<i>Eisenia fetida</i>)	Acute toxicity	14 days exposure, 22°C according to OECD guideline 207, purity 95.6%	LC ₅₀ >780 mg/kg dry soil	DI 8580
<i>Apis mellifera</i> (honey bee)	Acute oral toxicity and field test	Various laboratory, semi-field and field tests under varying conditions. BBA Guideline, purity 79.4% (Note 1).	LD ₅₀ >100 µg/bee (adults) Dimilin can be applied in the field without affecting honeybee colonies	DI 7234 DI 9386

Species	Test	Duration and conditions	Result	Reference
Bobwhite quail	Acute oral toxicity	Diflubenzuron administered as a single oral exposure by gavage, birds observed for 14 days. No guideline specified, purity 99.4%	LD ₅₀ >5000 mg/kg bw	DI 3598
Mallard duck	Acute oral toxicity	Diflubenzuron administered as a single oral exposure by gavage, birds observed for 14 days. No guideline specified, purity 99.4%	LC ₅₀ >5000 mg/kg bw	DI 3597
Mallard duck	8-day dietary exposure	Birds housed in thermostatically controlled brooders. No guideline specified, purity 100%	LC ₅₀ >4640 ppm diet (Note 2)	DI 3603
Bobwhite quail	8-day exposure	Birds housed in thermostatically controlled brooders. No guideline specified, purity 100%	LC ₅₀ >4640 ppm diet (Note 2)	DI 3604

Note 1: Due to the low solubility of diflubenzuron in water (0.08 mg/l), the acute toxicity was established using Dimilin WG-80 to suspend the active ingredient in water during the test.

Note 2: Highest dose tested.

Diflubenzuron was evaluated by IPCS in 1994 (IPCS 1994) and by the FAO/WHO JMPR for toxicology in 2001 (JMPR 2001) and for residues in 2002 under the periodic review programme of the Codex Committee on Pesticide Residues (JMPR 2002). The 2002 JMPR concluded that the long-term intake of residues of diflubenzuron in food resulting from its uses that have been considered by JMPR is unlikely to present a public health concern. The WHO panel of the 2001 JMPR 2001 that an acute RfD is unnecessary and therefore the 2002 JMPR concluded that the short-term intake of diflubenzuron residues is unlikely to present a public health concern. The 2001 JMPR re-confirmed the previously established ADI of 0-0.02 mg/kg bw.

The WHO hazard classification of diflubenzuron is: unlikely to present acute hazard in normal use (WHO 2002).

Formulations

The main formulation types available are WP (25%), SC (48%, 24%, 22%, 15%), WG (80%), GR (4%), OF (45% and 6%, the latter a ready-to-use formulation) for both agricultural and public hygiene use. Effervescent GR (2%) and DT (2%) formulations are under development and testing for use in public hygiene and submissions have been made for registration of this use.

These formulations are registered and sold in many countries throughout the world. Europe: Austria, Belarus, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Lithuania, Macedonia, Moldova, Netherlands, Norway, Poland, Portugal, Romania, Russia, Slovakia, Spain, Sweden, Switzerland, U.K. Uzbekistan, Yugoslavia. Middle East: Egypt, Iran, Israel, Jordan, Saudi Arabia, Syria, Turkey, United Arab Emirates. Africa: Algeria, Burkina Faso, Cape Verde, Chad, Gambia, Guinea Bissau, Kenya, Madagascar, Mali, Mauritania, Morocco, Niger, Senegal, South Africa, Zimbabwe. Australasia and Asia: Australia, P. R. China, India, Indonesia, Japan, Kazakhstan, Korea South, Kyrgyzstan, Malaysia, Nepal, New Zealand, Pakistan, Taiwan, Thailand. Americas: Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Guatemala, Mexico, Paraguay, Peru, USA, Uruguay.

Methods of analysis and testing

The analytical method for determination of the active ingredient (including identity tests) in the TK and WP is a full CIPAC method (CIPAC H). Diflubenzuron is determined by reversed-phase HPLC, using a C-18 column and acetonitrile/water mobile phase, with UV detection at 254 nm and linuron as the internal standard. The method has not been validated for GR, WG, OF, SC or DT formulations¹.

The methods for determination of impurities were based on HPLC-UV, using external standardization.

Test methods for determination of physico-chemical properties of the technical active ingredient were OECD, EPA and EC, while those for the formulations were CIPAC, as indicated in the specifications.

Containers and packaging

No special requirements for containers and packaging have been identified.

Expression of active ingredient

The active ingredient is expressed as diflubenzuron, in g/kg in solid formulations, and in g/kg or g/l at 20 ± 2°C in liquid formulations.

Appraisal

The Meeting considered data on diflubenzuron, submitted by Crompton Europe B.V. for the review of existing WHO specifications for the TK and WP. New specifications were considered for diflubenzuron granules (GR) and tablets for direct application (DT) in public health and for suspension concentrates (SC) for use in agriculture. The data submitted were in accordance with the requirements of the manual (FAO/WHO 2002).

Diflubenzuron is a benzoylurea insect growth regulator, used in agriculture, horticulture, forestry and public health applications. It is not under patent.

¹ Extension of the analytical method to GR, DT and SC was validated and adopted by CIPAC in 2005.

Diflubenzuron has low solubility in water and is stable in aqueous solution, although its half-life is significantly shorter at higher pH, and it is reasonably stable to photolysis.

The Meeting was provided with confidential information on the manufacturing process and manufacturing specifications for purity and impurities, which were supported by 5-batch analysis data, and a comparison of these data with those submitted for registration in the USA and EU. Mass balances in the 5-batch analyses were high (99.3-100.3%) and no unidentified impurities were detected. A statement was provided by the Australian Pesticides and Veterinary Medicines Authority, confirming that the confidential data on the manufacturing process and declaration of composition (specification limits for the active and impurities) for diflubenzuron provided to the APVMA by Crompton were identical to those provided to the FAO/WHO.

The Meeting agreed that none of the impurities should be regarded as relevant.

Diflubenzuron toxicity was assessed using the relatively pure TC, the TK (VC-90, 90% diflubenzuron), or, for wildlife studies in water, an 80% WG. Diflubenzuron is generally of low acute toxicity and, although a slight reaction was observed in eye irritation tests, this did not warrant its classification as an eye irritant according to EU Directive 67/548/EEC. Diflubenzuron was not observed to cause any carcinogenic, mutagenic, teratogenic or neurotoxic effects. Diflubenzuron is generally of low toxicity to other wildlife, other than insects, with *Daphnia magna* being the most sensitive species reported.

Diflubenzuron was last reviewed by IPCS in 1994 and by the FAO/WHO JMPR in 2001 and 2002. The WHO hazard classification is: unlikely to present acute hazard in normal use.

A full CIPAC analytical method is available for determination and identification of diflubenzuron in the TK and WP. It has not been validated according to CIPAC guidelines for the analysis of GR, DT or SC formulations but it was validated and compared with another method by the manufacturer in a GLP study, in accordance with U.K. PSD guidelines¹. The two methods are compared in the following table.

¹ U.K. Pesticides Safety Directorate. Guidelines for the Validation of Analytical Methods for Pesticides (PRD 2400), Commission Directive 96/46/EC and SANCO/3030/99 rev 4 'Guidance for generating and reporting methods of analysis in support of pre- and post-registration data requirements for Annex III (part A, Section 5) of Directive 91/414'.

	CIPAC Method 339/TK/M/-	GC Laboratories Ltd Method M569
Column	250 x 4.6 mm Zorbax TM _{BP} -C ₈ Spherisorb ODS 5 µm	250 x 4.6 mm 4 µm Synergi Polar-RP
Mobile phase	Acetonitrile-water-dioxane (450+450+100 v/v)	Dioxane-water (55+45 v/v)
Flow rate	1.3 ml/min	1.0 ml/min
Column temperature	Ambient	30°C
Detector wavelength	254 nm	254 nm
Injection volume	20 µl	5 µl
Internal standard	Linuron	Diphenyl phthalate
Retention times	Diflubenzuron about 7 min Linuron about 4 min	Diflubenzuron 8.9 min Diphenyl phthalate 12.5 min
Sample solute	Dioxane	Dimethylformamide

Test methods for the determination of physical properties of the TK and formulations are full CIPAC methods.

The proposed specifications were in accordance with the guidelines given in the manual (FAO/WHO 2002), with the following exceptions.

TK. The Meeting considered whether the specification related to a TC or TK but the manufacturer explained that the TK is a minimally diluted TC, intended for the manufacture of formulations. The nominal content of diflubenzuron in the TK was confirmed to be 900 g/kg, with a tolerance of ±25 g/kg, giving a minimum of 875 g/kg. Additional clauses were proposed for wet sieving, bulk density and particle size distribution. The manufacturer explained that control of particle size is important for good efficacy of the formulations prepared from the TK and the Meeting agreed that a clause for particle size should be included in the specification.

WP. The Meeting questioned the limit of 2 minutes for wettability. The manufacturer explained that this reflected the low affinity of diflubenzuron for water and the Meeting accepted the limit. The manufacturer specified a maximum retention of 1% in the wet sieve test, based on the use of a 44 µm test sieve. The Meeting agreed that the clause should be based on the usual 75 µm test sieve, the manufacturer stated that a limit of 1% would be required and this was accepted by the Meeting.

GR. The Meeting and manufacturer agreed that the term “bulk density” should be replaced by “pour density” and that a clause for pH range was unnecessary. The Meeting agreed that water should be specified as a relevant impurity and that a high limit is required for acidity, after the manufacturer explained that the granules contain an effervescent system, for disintegration of the granules after application to water for insect control. The granules are not intended for dispersion in water prior to application to water in the field and the Meeting agreed that it was not necessary to include a clause for granule disintegration.

DT. The Meeting and manufacturer agreed that a clause for pH range was unnecessary. The Meeting agreed that water should be specified as a relevant impurity and that a high limit is required for acidity, after the manufacturer explained that the tablets contain an effervescent system. The manufacturer explained that the majority of the acid present is not consumed in the effervescent reaction (which aids dispersion of the active ingredient) but, following application of the tablets to water for insect control, also aids dispersal of the active ingredient by simple dissolution. The tablets are not intended for dispersal in water prior to application in the field. Diflubenzuron is a slow-acting insecticide and effects on larvae are generally seen

after 24-48 hours. The manufacturer stated that, at water temperatures where mosquito larvae can survive, the tablets fully disintegrate within 10-30 minutes. The Meeting accepted that the high content of water-soluble acid should be sufficient to ensure dispersion, even in the absence of the effervescence reaction, and that therefore it was not necessary to include a clause for tablet disintegration.

SC. The Meeting and manufacturer agreed that a clause for acidity/alkalinity or pH is not required, because diflubenzuron has a very low solubility in water and does not dissociate. The manufacturer proposed a specification for wet sieve testing, based on a maximum retention of 0.1% of the formulation on a 150 µm test sieve. The Meeting agreed that the usual 75 µm test sieve should be specified. The manufacturer stated that tests indicated that maximum residue retention on a 75 µm sieve is less than 1% and the Meeting accepted this as an appropriate limit.

Recommendations

The Meeting recommended that:

- (i) existing WHO specifications for diflubenzuron TK and WP should be withdrawn;
- (ii) the proposed specification for diflubenzuron TK, as amended, should be adopted by FAO and WHO;
- (iii) the proposed specification for diflubenzuron SC, as amended, should be adopted by FAO, subject to CIPAC adoption of the analytical method extension to SC¹;
- (iv) the proposed specification for diflubenzuron WP, as amended, should be adopted by WHO;
- (v) the proposed specifications for diflubenzuron GR and DT should be adopted by WHO, subject to CIPAC adoption of the analytical method extensions to these formulations¹ and successful WHOPES testing/evaluation of the GR and DT for public health use².

References

Crompton document No.	Year and title or published reference
CIPAC H	Diflubenzuron, <i>in</i> W. Dobrat and A Martijn, Eds., CIPAC Handbook H, pp. 141-146. Collaborative International Pesticides Analytical Council, Harpenden, U.K., 1998.
DI 11387	1999. Determination of the dissociation constant of diflubenzuron.
DI 11496	1999. The boiling point of diflubenzuron technical.
DI 11497	1999. A 4-week inhalation toxicity study of Dimilin technical in rats.
DI 2168	1980. Subchronic dietary toxicity study in rats-diflubenzuron.
DI 2203	1977. Acute oral toxicity study with DU 112307 Technical in mice.
DI 2207	1973. Acute toxicity studies with DU 112307 in mice and rats.
DI 2212	1980. Ninety-day subchronic toxicity study in mice - diflubenzuron technical.

¹ Extension of the analytical method to GR, DT and SC was validated and adopted by CIPAC in 2005.

² WHOPES evaluation was successfully completed in 2005 (WHOPES 2005).

Crompton document No.	Year and title or published reference
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DI 2217	1975. Effect of repeated applications of DU 112307 to the skin of rabbits for three weeks.
DI 2227	1976. Acute toxicity in rats of DU 112307 Technical after dermal application.
DI 2261	1977. Mutagenic evaluation of diflubenzuron technical batch FL 44/605201.
DI 2263	1977. Evaluation of diflubenzuron in vitro malignant transformation in BALB/3t3 Cells.
DI 2264	1977. Evaluation of diflubenzuron unscheduled DNA synthesis in Wi-38 cells.
DI 2348	1974. Mutagenic study with TH 6040 In albino mice.
DI 2349	1975. Effect of DU 112307 on Pregnancy of the Rat.
DI 2350	1975, Effect Of DU 112307 on Pregnancy of the New Zealand white rabbit.
DI 2359	1975. Subacute inhalation toxicity to the rat of DU 112307 insecticide powder (technical) (evaluation of methaemoglobinaemia).
DI 2360	1975. Acute inhalation toxicity to the rabbit of DU 112307 technical grade powder.
DI 2375	1974. DU 112307 toxicity in repeated dietary administration to beagle dogs (repeated administration for 13 weeks).
DI 2376	1973. Dietary administration of DU 112307 to male and female rats for three months. 1973. Appendix III to Report No.56645/13a/1973 individual data: dietary administration of DU 112307 to male and female rats for 3 months.
DI 3462	1978. Effect of dietary administration of DU 112307 on reproductive function of one generation in the rat.
DI 3513	1973. Acute inhalation toxicity to the rat of DU 112307 technical grade powder.
DI 3516	1975. Effect of DU 112307 on reproductive function of multiple generations in the rat.
DI 3517	1979. Effects of DU 112307 in dietary administration to rats for 9 weeks.
DI 3522	1980 Histopathologic evaluation of mice administered diflubenzuron in the diet.
DI 3523	1974. DU 112307 preliminary assessment of the toxicity to male mice in dietary administration for 6 weeks.
DI 3525	1975. Tumorigenicity study of DU 112307 to mice. Dietary administration for 80 weeks.
DI 3528	1977. Addendum report to the chronic studies with DU 112307 a. dietary adm. to rats for 104 weeks b. dietary adm. to mice for 80 weeks.
DI 3597	1976. Study: acute oral toxicity in mallard ducks. Compound: TH6040 99.4% pure (air milled).
DI 3598	1976. Study: acute oral toxicity in bobwhite quail. Compound: TH 6040 99.4% pure (air milled).
DI 3603	1973. Eight-day dietary LC50-Mallard ducks Technical TH-6040 Final report.
DI 3604	1973. Eight-day dietary LC50-Bobwhite Quail Technical TH-6040 Final report.
DI 4037	1976. Effects of DU 112307 in dietary administration to rats for 104 weeks.
DI 4155	1981. The effects of dietary administration of diflubenzuron to male and female HC/CFLP mice for 14 weeks.
DI 4161	1977. Preliminary assessment of the effect of DU 112307 on the rat.
DI 4279	1980. Histopathologic evaluation of rats administered diflubenzuron in the diet.
DI 4852	1985. Diflubenzuron. 52 week oral toxicity study in dogs. (volume 1 and 2).
DI 4958	1984. Acute dermal toxicity study with diflubenzuron VC-90 in rats.
DI 4959	1984. Acute oral toxicity study with diflubenzuron VC-90 in rats.
DI 4960	1984. Primary irritation of diflubenzuron VC-90 to the rabbit eye.
DI 4961	1984. Primary irritation of diflubenzuron VC-90 to the rabbit skin.
DI 5707	1986. Mutagenicity evaluation of diflubenzuron technical in an in vitro cytogenetic assay measuring chromosome aberration frequencies in chinese hamster ovary cells.
DI 5710	1986. Diflubenzuron VC 90 acute inhalation toxicity study in rats (limit test).

Crompton document No.	Year and title or published reference
DI 6152	1987. Acute toxicity of diflubenzuron technical to sheepshead minnow (<i>Cyprinodon variegatus</i>).
DI 6552	1987. Diflubenzuron Oral (Gavage) Rat Teratology Limit Study.
DI 6553	1987. Diflubenzuron oral (gavage) rabbit teratology limit study.
DI 6689	1993. Photodegradation of [¹⁴ C]-diflubenzuron in water: an estimation of the quantum yield.
DI 6773	1988. The acute toxicity of diflubenzuron to <i>Daphnia magna</i> .
DI 6799	1988. Hydrolysis of ¹⁴ C-labelled diflubenzuron in buffer solutions at pH 5, pH 7 and pH 9.
DI 7016	1988. Determination by HPLC of the log P value of diflubenzuron and its primary metabolites.
DI 7081	1988. The vapour pressure of diflubenzuron.
DI 7233	1989. Solubility of diflubenzuron in water at 298 K.
DI 7234	Kuijpers, L.A.M. 1993. The impact of Dimilin on honey-bees: a review.
DI 7987	1990. Evaluation of DNA repair inducing ability of diflubenzuron in a primary culture of rat hepatocytes (with independent repeat).
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DI 8146	1984. The effect of diflubenzuron given by oral administration with the feed on toxicity and tumour development in male and female HC/CFLP mice.
DI 8147	1984. Oncogenicity study in rats, diflubenzuron.
DI 8423	1992. Sensitization study with diflubenzuron technical in guinea pigs.
DI 8580	1992. The acute toxicity of diflubenzuron to the earthworm <i>Eisenia fetida</i> .
DI 8667	1993. Diflubenzuron: a 5-day toxicity test with the freshwater alga (<i>Selenastrum capricornutum</i>).
DI 8668	1993. Diflubenzuron: A 96-hour flow-through acute toxicity test with the sheepshead minnow (<i>Cyprinodon variegatus</i>).
DI 8925	1994. The acute toxicity of diflubenzuron to zebra fish (<i>Brachydanio rerio</i>).
DI 8926	1994. The acute toxicity of diflubenzuron to rainbow trout (<i>Oncorhynchus mykiss</i>).
DI 8927	1994. The acute toxicity of Dimilin WG-80 to rainbow trout (<i>Oncorhynchus mykiss</i>).
DI 8929	1994. The acute toxicity of Dimilin WG-80 to zebra fish (<i>Brachydanio rerio</i>).
DI 9104	1994. The acute toxicity of Dimilin WG-80 to the alga <i>Selenastrum capricornutum</i> .
DI 9167	1995. Solubility of diflubenzuron at pH 4, 7 and 10.
DI 9180	1995. The acute toxicity of Dimilin WG-80 to <i>Daphnia magna</i> compared to diflubenzuron.
DI 9182	1995. Diflubenzuron technical – the effect on reproductive function of two generations in the rat. 1995. Diflubenzuron technical – the effect on reproductive function on two generations in the rat: addendum 1 – individual pups body weights
DI 9321	1995. Determination of the UV-vis spectra and melting point of diflubenzuron.
DI 9386	1995. Assessment of side effects of Dimilin WG-80 on the honey bee (<i>Apis mellifera</i> L.) in the field by application during bee flight.
DI 9429	1996. 21-day dermal toxicity study in rats.
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Crompton document No.	Year and title or published reference
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