Food and Agriculture Organization
of the United Nations

FAO SPECIFICATIONS AND EVALUATIONS

FOR AGRICULTURAL PESTICIDES

CLODINAFOP-PROPARGYL

prop-2-ynyl (R)-2-[4-(5-chloro-3-fluoro-2-pyridyloxy)phenoxy]propionate

2020

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DISCLAIMER[1]

FAO 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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[1] This disclaimer applies to all specifications published by FAO.

INTRODUCTION

FAO establishes and publishes specifications for technical material and related formulations of agricultural 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 1999 onward, the development of FAO specifications follows the **New Procedure**, described first in the 5th edition of the "Manual on the development and use of FAO specifications for plant protection products" and later in the 1st edition of "Manual for Development and Use of FAO and WHO Specifications for Pesticides" (2002) - currently available as 3rd revision of the 1st edition (2016) - , which is available only on the internet through the FAO and WHO web sites.

This **New Procedure** follows a formal and transparent evaluation process. It describes the minimum data package, the procedure and evaluation applied by FAO and the Experts of the FAO/WHO Joint Meeting on Pesticide Specifications (JMPS). [Note: prior to 2002, the Experts were of the FAO Panel of Experts on Pesticide Specifications, Registration Requirements, Application Standards and Prior Informed Consent, which now forms part of the JMPM, rather than the JMPS.]

FAO Specifications now only apply to products for which the technical materials have been evaluated. Consequently from the year 1999 onwards the publication of FAO 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 "Manual on development and use of FAO and WHO specifications for pesticides".

Part Two: The Evaluation Report(s) of the pesticide, reflecting the evaluation of the data package carried out by FAO 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.

FAO specifications developed 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. FAO 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. Evaluations bear the date (year) of the Meeting at which the recommendations were made by the JMPS.

PART ONE

SPECIFICATIONS

CLODINAFOP-PROPARGYL

CLODINAFOP-PROPARGYL

INFORMATION

ISO common names

clodinafop (BSI, E-ISO)
clodinafop-propargyl (modified E-ISO) denotes the propargyl ester

Synonyms

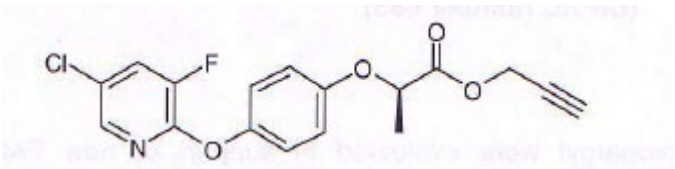
none

Chemical names

clodinafop:
IUPAC (*R*)-2-[4-(5-chloro-3-fluoro-2-pyridyloxy)phenoxy]propionic acid
CA (2*R*)-2-[4-[(5-chloro-3-fluoro-2-pyridinyl)oxy]phenoxy]propanoic acid

clodinafop-propargyl:
IUPAC prop-2-ynyl (*R*)-2-[4-(5-chloro-3-fluoro-2-pyridyloxy)phenoxy]propionate
CA 2-propynyl (2*R*)-2-[4-[(5-chloro-3-fluoro-2-pyridinyl)oxy]phenoxy]propanoate

Structural formula (clodinafop-propargyl)



clodinafop and clodinafop-propargyl are the *R*-enantiomers

Empirical formula

clodinafop: $C_{14}H_{11}ClFNO_4$
clodinafop-propargyl: $C_{17}H_{13}ClFNO_4$

Relative molecular mass

clodinafop: 311.8
clodinafop-propargyl: 349.8

CAS Registry number

clodinafop: 114420-56-3
clodinafop-propargyl: 105512-06-9

CIPAC number

clodinafop: 683
clodinafop-propargyl: 683.225

Identity tests

HPLC retention times on reversed-phase and enantioselective columns.

CLODINAFOP-PROPARGYL TECHNICAL MATERIAL

FAO specification 683.225 / TC (June 2020)

This specification, which is PART ONE of this publication, is based on an evaluation of data submitted by the manufacturers whose name are listed in the evaluation reports (683.225/2006 & 683.225/2019). It should be applicable to TC produced by this manufacturer but it is not an endorsement of it, nor a guarantee that it complies with the specification. The specification may not be appropriate for TC produced by other manufacturers. The evaluation reports 683.225/2006 & 683.225/2019, as PART TWO, form an integral part of this publication.

1 Description

The material shall consist of clodinafop-propargyl together with related manufacturing impurities and shall be a white or light beige to light brown powder, free from visible extraneous matter and added modifying agents.

2 Active ingredient

2.1 **Identity tests** (683/TC/M/2, CIPAC Handbook M, p. 27, 2009)

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 **Clodinafop-propargyl content** (683/TC/M/3.1 and 683/TC/M/3.2, CIPAC Handbook M, p. 27 and p. 30, 2009) (Note 1)

The clodinafop-propargyl content shall be declared (not less than 960 g/kg) and, when determined, the average measured content shall not be lower than the declared minimum content.

Note 1: As outlined in the method, the determination of the content of clodinafop-propargyl in TC consists of two complementary methods: a chemical purity method to assess the content of of the sum of clodinafop-propargyl and its *S*-enantiomer in TC (683/TC/M/3.1) and a second enantioselective method (683/TC/M/3.2) to determine the contribution of the *S*-enantiomer of clodinafop-propargyl to the result obtained with the chemical purity method (enantomeric purity method).

CLODINAFOP-PROPARGYL WETTABLE POWDER

FAO Specification 683.225 / WP (June 2020)

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 (683.225/2006). It should be applicable to relevant products of this manufacturer, and those of any other formulators who use only TC from the evaluated source. The specification is not an endorsement of those products, nor a guarantee that they comply with the specification. The specification may not be appropriate for the products of manufacturers who use TC from other sources. The evaluation report 683.225/2006, as PART TWO, forms an integral part of this publication.

1 Description

The material shall consist of technical clodinafop-propargyl, complying with the requirements of FAO Specification 683.225/TC (June 2020), together with filler(s) and any other necessary formulants. It shall be in the form of a fine powder free from visible extraneous matter and hard lumps.

2 Active ingredient

2.1 **Identity tests** (683.225/WP/M/2, CIPAC Handbook M, p. 32, 2009)

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 **Clodinafop-propargyl content** (683.225/WP/M/3.1 and 683.225/WP/M/3.2, CIPAC Handbook M, p. 32, 2009), (Note 1)

The clodinafop-propargyl 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 Note: the upper limit is included in the range	± 6% of the declared content

3 Physical properties

3.1 **pH range** (MT 75.3, CIPAC Handbook J, p.131, 2000)

The pH of an aqueous dispersion shall be 4.0 to 8.0.

3.2 **Wet sieve test** (MT 185, CIPAC Handbook K, p.149, 2003)

Maximum: 2% retained on a 75 µm test sieve.

3.3 **Suspensibility** (MT 184.1) (Notes 2, 3 & 4)

A minimum of 60% of the clodinafop-propargyl content found under 2.2 shall be in suspension after 30 min in CIPAC standard water D at 25 ± 5°C.

3.4 **Persistent foam** (MT 47.3, CIPAC Handbook O, p.177, 2017) (Note 5)

Maximum: 60 ml after 1 min.

3.5 **Wettability** (MT 53.3.1, CIPAC Handbook F, p.165, 1995)

The formulation shall be completely wetted in 1 min without swirling.

4 Storage stability

4.2 **Stability at elevated temperature** (MT 46.4) (Note 6)

After storage at 54 ± 2°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 7) and the formulation shall continue to comply with the clauses for:

- pH range (3.1),
- wet sieve test (3.2),
- suspensibility (3.3),
- wettability (3.5).

Note 1: As outlined in the method, the determination of the content of clodinafop-propargyl in WP consists of two complementary methods: a chemical purity method to assess the content of of the sum of clodinafop-propargyl and its *S*-enantiomer in the WP (683/WP/M/3.1) and a second enantioselective method (683/WP/M/3.2) to determine the contribution of the *S*-enantiomer of clodinafop-propargyl to the result obtained with the chemical purity method (enantomeric purity method).

Note 2 The revision of CIPAC method MT 184, Suspensibility of formulations forming suspensions on dilution with water (CIPAC/5156) was accepted as full CIPAC method in 2019. Prior to its publication in the next Handbook, copies of the method can be obtained through the CIPAC website, http://www.cipac.org/index.php/methods-publications/pre-published-methods

Note 3 The product should be test at highest and lowest rates of use recommended by the supplier, provided this does not exceed the conditions given in method MT 184.1.

Note 4 Chemical assay is the only fully reliable method to measure the mass of active ingredient still in suspension. However, simpler methods such as gravimetric determination or solvent extraction determination may be used on a routine basis provided that these methods have been shown to give equal results to those of chemical assay method. In case of dispute, chemical method shall be the "referee method".

Note 5 The mass of sample to be used in the test should be at the highest rate of use recommended by the supplier.

Note 6 MT 46.4 is the harmonized and updated accelerated storage method. It was presented and provisionally adopted at the 2019 CIPAC Meeting in Braunschweig. Prior to its publication in a next Handbook, copies of the method can be obtained through the CIPAC website http://www.cipac.org/index.php/methods-publications/pre-published-methods

Note 7 Samples of the formulation taken before and after the storage stability test may be analyzed concurrently after the test in order to reduce the analytical error.

CLODINAFOP-PROPARGYL EMULSIFIABLE CONCENTRATE

FAO Specification 683.225 / EC (June 2020)

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 (683.225/2006). It should be applicable to relevant products of this manufacturer, and those of any other formulators who use only TC from the evaluated source. The specification is not an endorsement of those products, nor a guarantee that they comply with the specification. The specification may not be appropriate for the products of manufacturers who use TC from other sources. The evaluation report 683.225/2006, as PART TWO, forms an integral part of this publication.

1 Description

The material shall consist of technical clodinafop-propargyl, complying with the requirements of FAO specification 683.225/TC (June 2020), dissolved in suitable solvents, together with any other necessary formulants. It shall be in the form of a clear to slightly hazy, stable homogeneous liquid, free from visible suspended matter and sediment, to be applied as an emulsion after dilution in water.

2 Active ingredient

2.1 **Identity tests** (683.225/EC/M/2, CIPAC Handbook M, p. 34, 2009)

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 **Clodinafop-propargyl content** (683.225/EC/M/3.1 and 683.225/EC/M/3.2, CIPAC Handbook M, p. 34, 2009) (Note 1)

The clodinafop-propargyl content shall be declared (g/kg or g/l at 20 ± 2ºC, Note 2) and, when determined, the average measured content shall not differ from that declared by more than the following tolerances:

Declared content, g/kg or g/l at 20 ± 2ºC	Tolerance
above 25 up to 100	± 10% of the declared content
above 100 up to 250	± 6% of the declared content
Note: the upper limit is included in each range	

3 Physical properties

3.1 **pH range** (MT 75.3, CIPAC Handbook J, p.131, 2000)

The pH of an aqueous dispersion shall be 4.0 to 8.0.

3.2 **Emulsion stability and re-emulsification** (MT 36.3, CIPAC Handbook K, p.137, 2003) (Note 3)

The formulation, when diluted at 30 ± 2°C with CIPAC standard waters A and D, shall comply with the following:

Time after dilution	Limits of stability
0 h	Initial emulsification complete
0.5 h	Cream, maximum: 2 ml
2.0 h	"Cream", maximum: 4 ml "Free oil", maximum: trace
24 h	Re-emulsification complete
24.5 h	"Cream", maximum: 2 ml "Free oil" maximum: trace.
Note: tests at 24 h are required only where the results at 2 h are in doubt.	

3.3 **Persistent foam** (MT 47.3, CIPAC Handbook O, p.177, 2017) (Note 4)

Maximum: 40 ml after 1 min.

4 Storage stability

4.1 **Stability at 0°C** (MT 39.3, CIPAC Handbook J, p.126, 2000)

After storage at 0 ± 2°C for 7 days, the volume of solid and/or liquid which separates shall not be more than 0.3 ml.

4.2 **Stability at elevated temperature** (MT 46.4) (Note 5)

After storage at 54 ± 2°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 6) and the formulation shall continue to comply with the clauses for:

- pH range (3.1);
- emulsion stability and re-emulsification (3.2).

Note 1: As outlined in the method, the determination of the content of clodinafop-propargyl in EC consists of two complementary methods: a chemical purity method to assess the content of of the sum of clodinafop-propargyl and its *S*-enantiomer in the EC formulation (683/EC/M/3.1) and a second enantioselective method (683/EC/M/3.2) to determine the contribution of the *S*-enantiomer of clodinafop-propargyl to the result obtained with the chemical purity method (enantomeric purity method).

Note 2 If the buyer requires both g/kg and g/l at 20°C, then in case of dispute the analytical results shall be calculated as g/kg.

Note 3 This test will normally only be carried out after the heat stability test, 4.2. Emulsion stability should be tested with the formulation at 0.1% concentration.

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 MT 46.4 is the harmonized and updated accelerated storage method. It was presented and provisionally adopted at the 2019 CIPAC Meeting in Braunschweig. Prior to its publication in a next Handbook, copies of the method can be obtained through the CIPAC website https://www.cipac.org/index.php/methods-publications/pre-published-methods

Note 6 Samples of the formulation taken before and after the storage stability test may be analyzed concurrently after the test in order to reduce the analytical error.

PART TWO

EVALUATION REPORTS

CLODINAFOP-PROPARGYL

CLODINAFOP-PROPARGYL

FAO/WHO EVALUATION REPORT 683.225 / 2019

Recommendations

The Meeting recommended that:

(I) The clodinafop-propargyl TC produced by Zhejiang Udragon Bioscience Co. Ltd. should be accepted as equivalent to the clodinafop-propargyl TC reference profile

(II) the existing FAO specification for clodinafop-propargyl TC (2008) should be extended to encompass the TC from Zhejiang Udragon Bioscience Co. Ltd.

Appraisal

The Meeting considered data for clodinafop-propargyl submitted by Zhejiang Bosst CropScience Co. Ltd (Zheijang Bosst) between April 2017 and March 2019. In May 2020, Zheijang Bosst announced the change of the name of the company from Zhejiang Bosst CropScience Co. Ltd to Zhejiang Udragon Bioscience Co. Ltd. (Zhejiang Udragon) which is used throughout this evaluation.

The data were evaluated in support of an extension of the existing FAO specification 683.225/TC (2008).

The reference specification and supporting data were provided by Syngenta and published in 2008. The data are broadly in accordance with the requirements of the 2016 revision of the FAO/WHO Manual.

Clodinafop-propargyl is not under patent and the compound has neither been evaluated by the FAO/WHO JMPR nor by WHO/IPCS.

The manufacturer submitted confidential data on the manufacturing process together with the manufacturing specification and 5-batch analysis data on purity and impurities ≥ 1 g/kg and a reverse-mutation-test.

The confidential data presented differ from those submitted for registration in China. The differences are the 5-batches analysis report, the acute toxic studies reports and phys-chemical study report. The 5-batches analysis for registration in China was conducted in 2012, the data submitted to FAO were from 2016. A comparison of the registration data held at ICAMA and the submitted data revealed that this is acceptable. The batches analysed 2016 show an impurity profile which is covered by the data set submitted for registration.

The registration in China is under review based on those new GLP data. This was considered sufficient by the Meeting.

The manufacturing process was compared to to that of the reference process. The process used by Zhejiang Udragon is similar as that of the reference.

The Meeting noted, that the 5 batches were produced within a rather narrow time span (two months).

No induction of reverse mutation *in vitro* was observed, so the Meeting concluded that based on the purity/impurity profile and the absence of reverse mutation the material produced by

Zhejiang Udragon can be considered as equivalent to the reference produced by Syngenta based by Tier-1.

The company validated and used a HPLC method based on UV detection at 230 nm for the determination of the content of clodinafop-propargyl in the TC

This method is based on the published CIPAC method 683.225/TC/M/3.1 in Handbook M. But while the published TC specification is based on the use of a combination of the chemical purity method (reversed phase HPLC) and an enantioselective HPLC method, in the submitted dossier only the second method is used.

The Meeting noted that the ISO common name refers to the *R*-enantiomer only, so appropriate information on both total content ("chemical purity") and the content of the R-isomer (enantiomeric purity) must be provided to demonstrate equivalence with the published specification. The two assays are complementary: the chemical purity determines the sum of *R*- and *S*-enantiomer in the TC, whereas the enantiomeric purity assay determines the contribution of the *S*-enantiomer (that is not a part of the ISO common name definition) to the overall content of clodinafop-propargyl in the TC. Therefore, the approach suggested by the company was deemed to be insufficient, and the analysis of the 5 batches should be repeated using the chemical purity (non-chiral method) too.

The company submitted a new 5-batch report. But in this report 5 new batches were analysed using only the non-chiral method for determination of the chemical purity. So a bridging with the original submitted data is difficult.

The Meeting asked for additional data and the company submitted a further bridging study analysing the second 5 batches also by the chiral method. Here no *S*-enantiomer was detected, so the Meeting concluded that these data are deemed acceptable.

No physical-chemical studies were submitted for registration in China.

The melting point of the pure active ingredients is very close to the melting point of the reference material.

In addition, the Meeting recommended to editorially update the clodinafop-propargyl TC and formulation specifications for the now published analytical methods in Handbook M and latest versions of CIPAC MT methods like persistent foam (MT 47.3 replaces MT 47.2), suspensibility (MT 184.1) and MT 46.4 for the accelerated storage.

The Meeting noted that the description of the TC produced by Zhejiang Udragon is slightly different from that of the reference TC: whereas the Syngenta TC is "light to (light) brown", the material produced by Zhejiang Udragon is an"off-white to white powder ". The description clause was therefore adapted to encompass both the Zhejiang Udragon and Syngenta materials into "white to light beige to light brown". The less coloured material indicates a lower amount of impurities absorbing light at certain wavelengths and is therefore deemed to be equivalent, based on the rules of the Manual (Section 3.2). A comparison of the melting ranges (Zhejiang Udragon 59.1 to 59.9 °C, Syngenta 48.2-57.1°C) also indicates a slightly higher typical purity of the Zhejiang Udragon technical material.

SUPPORTING INFORMATION
FOR
EVALUATION REPORT 683.225/2019

Table 1.Chemical composition and properties of clodinafop-propargyl TC

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 99.17 – 99.51 % and percentages of unknowns were 0.49 – 0.83 %			
Declared minimum clodinafop-propargyl content	970 g/kg			
Relevant impurities ≥ 1 g/kg and maximum limits for them	None			
Relevant impurities **<** 1 g/kg and maximum limits for them:	None			
Stabilisers or other additives and maximum limits for them:	None			
Parameter	Value and conditions	Purity %	Method reference	Study number
Melting temperature range of the TC	59.1 - 59.9 °C	98.1 %	OECD 102	2016G144
Solubility in organic solvents	> 250 g/l in toluene > 250 g/L in acetone at 20 °C	98.1 %	CIPAC MT 181	2016G139

FORMULATIONS AND CO-FORMULATED ACTIVE INGREDIENTS

The main formulation type available is a WP formulation. Yet the company has proposed an equivalence for the TC only.

METHODS OF ANALYSIS AND TESTING

The analytical methods for identification and determination of clodinafop-propargyl content is based on a non-chiral separation using reversed-phase HPLC with external standardization and UV detection at 305 nm. For quantification of the optical antipode of clodinafop-propargyl (the S-enantiomer), an enantioselective HPLC-method is used with external standardization and UV detection at 230 nm.

Test methods for determination of physico-chemical properties of the technical active ingredient were OECD and CIPAC, where appropriate.

CONTAINERS AND PACKAGING

No special requirements for containers and packaging have been identified.

EXPRESSION OF THE ACTIVE INGREDIENT

The active ingredient is expressed as clodinafop-propargyl.

ANNEX 1

HAZARD SUMMARY PROVIDED BY THE PROPOSER

Notes.

(i) The proposer confirmed that the toxicological and ecotoxicological data included in the summary below were derived from clodinafop-propargyl having impurity profile similar to those referred to in the Table 1 above.

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

Table2. Mutagenicity profile of clodinafop-propargyl technical material based on an *in vitro* test

Species	Test	Purity %	Guideline, duration, doses and conditions	Result	Study number
S. typhimurium strains TA 1535, TA 1537, TA 98, TA 100 and TA 102	Bacterial Reverse Mutation Assay *in vitro*	98.1 %	OECD guideline 471, Duration: 28 days Dose and condition: 0.0125, 0.0396, 0.1252, 0.3956 and 1.25 mg/plate both in presence (+S9) and in absence (-S9) of metabolic activation	Negative - clodinafop-propargyl TC has shown to not induce gene mutations either by base pair substitution or by frame shifts in the genome of the strains used under the conditions of the assay with and without metabolic activation.	6654

ANNEX 2

REFERENCES

Study number	Author	Year	Study title. Study identification number. Report identification number. GLP [if GLP]. Company conducting the study.
	FAO/WHO	2016	Manual on development and use of FAO and WHO specifications for pesticides. 2016, 3rd revision of the 1st edition.
2016G144	Hou Songmei	2016	Chemical and Physical Characterization of Clodinafop-propargyl TC: Melting Point, 2016G144, GLP, Pesticides Test Laboratory of Shenyang Research Institute of Chemical Industry, China, Unpublished.
2016G139	Hou Songmei	2016	Solubility in Organic Solvents Test of Clodinafop-propargyl TC, study and report number 2016G139, GLP, Pesticides Test Laboratory of Shenyang Research Institute of Chemical Industry, China, Unpublished.
Study number 6654		2016	Bacterial Reverse Mutation Assay with Clodinafop-propargyl TC, GLP, Unpublished

CLODINAFOP-PROPARGYL

EVALUATION REPORT 683.225/2006

Recommendations

The Meeting recommended that the specifications for clodinafop-propargyl TC, EC and WP, proposed by Syngenta Crop Protection AG, should be adopted by FAO.

Appraisal

The Meeting considered data on clodinafop-propargyl, submitted by Syngenta Crop Protection AG, in support of proposed new FAO specifications for TC, EC and WP.

Clodinafop-propargyl is not under patent in most countries.

The ISO common name, clodinafop, applies to the free acid, whereas esters or salts of the acid may be identified by addition of the appropriate extension to the name. The clodinafop molecule has one centre of asymmetry and the ISO common name applies only to the *R*-enantiomer, not the *S*-enantiomer. The modified ISO common name, clodinafop-propargyl (denoting the propargyl ester), therefore applies only to the *R*-enantiomer.

Clodinafop-propargyl is a solid at room temperature, having low volatility and low water solubility but it is very soluble in certain organic solvents, such as acetone and toluene. It hydrolyzes only slowly in water under acidic conditions but is rapidly hydrolyzed under alkaline conditions. Photolysis occurs rapidly, producing a plethora of products but not including clodinafop (free acid). Clodinafop-propargyl, as the intact ester, has no acidic or basic characteristics.

Confidential information on the manufacturing process and 5 batch analysis data for all impurities present at or above 1 g/kg were provided to the Meeting, together with the manufacturing specification for the TC. The minimum active ingredient content in clodinafop-propargyl TC was not less than 960 g/kg. These data were confirmed as being similar to those submitted for registration in The Netherlands and for assessment in the EU.

The Meeting agreed with the manufacturer that none of the impurities should be designated as relevant, for specification purposes.

Draft specifications were submitted broadly in accordance with the requirements of the Manual (FAO/WHO, 2006) but the Meeting addressed the following minor issues.

WP and EC, pH range. The Meeting questioned the proposed upper limit (pH 8), given the rapidity of hydrolysis of clodinafop-propargyl at pH 9, and, if hydrolysis does not actually occur in practice, whether the pH range is an appropriate quality criterion. The manufacturer stated that racemization and/or hydrolysis can occur in products outside the proposed pH range (4.0-8.0), with hydrolysis being the main issue as there is always a small amount of water present in these formulations. Within the proposed range, the active ingredient was stated to be stable. Although hydrolysis or racemization may be detected in the storage stability test, the manufacturer explained that pH range provides a simple and rapid indication of product stability and the Meeting accepted this justification.

WP and EC, persistent foam. The Meeting asked whether proposed limit of 60 ml for the WP could be lower, as it was the maximum normally accepted. The manufacturer explained that the proposed limit represented the optimum compromise between adequate suspensibility and the production of foam. The Meeting accepted the proposed limit. In contrast, and on the basis of data provided by the manufacturer, the Meeting questioned whether the proposed limit of 40 ml for EC would be too low. The Meeting accepted the manufacturer's assurance that the EC complies with the limit .

Analytical methods for the identification and determination of clodinafop-propargyl in TC, WP and EC were adopted by CIPAC, with provisional status, in 2006. Determination and primary identification is by (achiral) reversed-phase HPLC method (in which *R*- and *S*-enantiomers are not separated), with detection by UV-absorption at 305 nm and external standardization. Confirmation of identity in the TC and formulations is by enantio-selective HPLC, with detection by UV-absorption at 230 nm and measurement of the peak area ratio of *R*- and *S*-enantiomers present. The clodinafop-propargyl content measured by reversed-phase HPLC is adjusted by the ratio found by enantio-selective HPLC, because the *S*-enantiomer is not part of the active ingredient.

SUPPORTING INFORMATION
FOR
EVALUATION REPORT 683.225/2006

Uses

Clodinafop-propargyl is a systemic herbicide, used in agriculture for the post-emergence control of annual grass weeds in cereals.

Identity of the active ingredient

ISO common names

clodinafop (BSI, E-ISO)
clodinafop-propargyl (modified E-ISO) denotes the propargyl ester

Synonyms

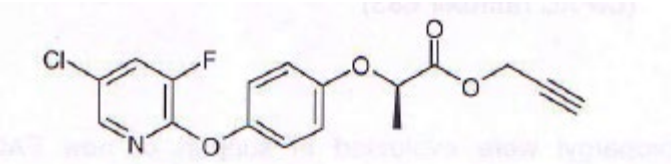
none

Chemical names

clodinafop:
IUPAC (*R*)-2-[4-(5-chloro-3-fluoro-2-pyridyloxy)phenoxy]propionic acid
CA (2*R*)-2-[4-[(5-chloro-3-fluoro-2-pyridinyl)oxy]phenoxy]propanoic acid

clodinafop-propargyl:
IUPAC prop-2-ynyl (*R*)-2-[4-(5-chloro-3-fluoro-2-pyridyloxy)phenoxy]propionate
CA 2-propynyl (2*R*)-2-[4-[(5-chloro-3-fluoro-2-pyridinyl)oxy]phenoxy]propanoate

Structural formula (clodinafop-propargyl)



clodinafop and clodinafop-propargyl are the *R*-enantiomers

Empirical formula

clodinafop: $C_{14}H_{11}ClFNO_4$
clodinafop-propargyl: $C_{17}H_{13}ClFNO_4$

Relative molecular mass

clodinafop: 311.8
clodinafop-propargyl: 349.8

CAS Registry number

clodinafop: 114420-56-3
clodinafop-propargyl: 105512-06-9

CIPAC number

clodinafop: 683
clodinafop-propargyl: 683.225

Identity tests

HPLC retention times on reversed-phase and enantio-selective columns.

Physico-chemical properties of clodinafop-propargyl

Table 1. Physico-chemical properties of pure clodinafop-propargyl

Parameter	Value(s) and conditions	Purity %	Method	Reference [company report No.; year of completion]
Vapour pressure	3.19 x 10^{-6} Pa at 25ºC (extrapolated)	99.5%	EEC A.4	CGA184927 /0232; 1992
Melting point	59.5°C	99.5%	EEC A.1	CGA184927 /0478; 1994
Boiling point	100.6°C at 0.082 Pa	99.9%	EEC A.2	CGA184927 /4628; 1997
Temperature of decomposition	starts at about 285°C	99.5%	EEC A.2 OECD 113	CGA184927 /4628; 1997 CGA184927 /4709; 2000
Solubility in water	4.0 mg/l at 25°C	99.5%	OECD 105	CGA184927 /0230; 1991
Octanol/water partition coefficient	log P_{OW} = 3.90 at 25°C	99.5%	OECD 117	CGA184927 /0231; 1991
Hydrolysis characteristics, half-life at 25ºC	17.9 days at pH 4 26.8 days at pH 5 4.8 days at pH 7 0.07 days (1.68 hours) at pH 9	>99%	OECD 111	CGA184927 /4851; 2001
Photolysis characteristics	In bi-distilled water at 25°C and irradiated with a mercury arc lamp, with and without acetone as a sensitizer, photolysis half-lives were: non-sensitized, 3.2 hours sensitized, 0.7 hours These values correspond to estimated half-lives of 8.5 days and 6.0 days at latitude 40°N in spring/summer and 12.5days and 7.0 days at latitude 50°N in spring/summer. The photodecomposition led to a multitude of products, which were more polar than clodinafop-propargyl and which could not be identified. Clodinafop (free acid) was not found. No significant degradation occurred in the dark control. The average material balance was 99.6%.	>98% radio-purity	In-house adaptation of EPA and OECD guidelines	CGA184927 /0017; 1990
Dissociation characteristics	Protonation/deprotonation of clodinafop-propargyl is not expected to occur in the range pH 2 to 12 (liberation of the free acid by hydrolysis occurs rapidly under alkaline conditions)	-	By estimation	CGA184927 /0234; 1991

Table 2. Chemical composition and properties of technical clodinafop-propargyl (TC)

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 98.7-99.5%, with no unknowns detected.

Declared minimum clodinafop-propargyl content	960 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 temperature of the TC	48.2-57.1°C

Hazard summary

Clodinafop-propargyl has not been evaluated by the FAO/WHO JMPR, nor by IPCS.

An EU review of clodinafop-propargyl (according to EU directive 91/414) was completed recently (EU 2005). According to European Commission Directive 2001/59/EC (28th adaptation of Council Directive 67/548/EEC), it was classified as harmful with respect to acute toxicity.

The US EPA published tolerances for clodinafop-propargyl in 2000 (USEPA 2000).

Clodinafop-propargyl has not yet (December 2006) been assigned a WHO hazard classification by the WHO Programme on Chemical Safety.

Formulations

The main formulation types available are EC and WP. EC formulations are registered and sold in many countries throughout the world. WP formulations are currently registered and sold in Asia and Egypt. Clodinafop-propargyl is always co-formulated with a safener.

Methods of analysis and testing

The analytical method for identification and determination of clodinafop-propargyl content is based on a non-chiral separation using reversed-phase HPLC with external standardization and UV detection at 305 nm. For identification of clodinafop-propargyl as the *R*-isomer, a quantitative chiral method is used, involving enantio-selective HPLC with external standardization and UV detection at 230 nm. The methods for analysis of TC, WP and EC were adopted by CIPAC with provisional status in 2006.

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

Physical properties

The physical properties, the methods for testing them and the limits proposed for the EC and WP formulations, comply with the requirements of the manual (FAO/WHO 2006).

Containers and packaging

No special requirements for containers and packaging have been identified.

Expression of the active ingredient

The active ingredient is expressed as clodinafop-propargyl.

ANNEX 1

HAZARD SUMMARY PROVIDED BY THE PROPOSER

Note: Syngenta provided written confirmation that the toxicological and ecotoxicological data included in the following summary were derived from clodinafop-propargyl having impurity profiles similar to those referred to in Table 2, above.

Table A. Toxicology profile of clodinafop-propargyl technical material, based on acute toxicity, irritation and sensitization

Species	Test	Purity	Duration and conditions or guideline adopted	Result	Reference
Rat (m,f)	Acute oral	93.7%	OECD 401. 14 d observation period; dose levels 500, 2000 or 5000 mg/kg bw.	LD_{50} = 1829 mg/kg bw (males 1392 mg/kg, females 2271 mg/kg)	CGA184927/ 0045; 1987
Mouse	Acute oral	94.2%	OECD 401. 14 d observation period; highest dose 2000 mg/kg bw	LD_{50} >2000 mg/kg bw	CGA184927/ 0169; 1991
Rat	Acute dermal	93.7%	OECD 402. 14 d observation period; highest dose 2000 mg/kg bw	LD_{50} >2000 mg/kg bw	CGA184927/ 0034; 1987
Rat	Acute inhalation	93.7%	OECD 403. 4 h exposure, 14 d observation period; nominal concentration 2340 mg/m^3	LC_{50} >2325 mg/m^3	CGA184927/ 0035; 1987
Rabbit	Skin irritation	93.7%	OECD 404. 1-72 h; dose 0.5 g/ml	Non-irritating	CGA184927/ 0036; 1987
Rabbit	Eye irritation	93.7%	OECD 405. 1-72 h; 48 mg/eye	Non-irritating	CGA184927/ 0037; 1987
Guinea pig	Skin sensitization (optimization test)	93.7%	OECD 406. 48 h; dose 0.1% or 5%	Sensitizer	CGA184927/ 0039; 1987

According to the manufacturer, clodinafop-propargyl is classifiable as Class III (slightly hazardous) by the WHO hazard classification system.

Table B. Toxicology profile of clodinafop-propargyl technical material, based on repeated administration (sub-acute to chronic)

Species	Test	Purity	Duration and conditions or guideline adopted	Result	Reference
Rat, Tif:RAIf, Sprague-Dawley	Short term toxicity	93.7%	3 month dietary; OECD 408, dose levels: 0, 2, 15, 120, 1000 ppm	NOAEL = 0.92 mg/kg bw/d (15 ppm) LOAEL = 8.24 mg/kg bw/d (120 ppm)	CGA184927/ 0041; 1989
Dog, beagle	Short term toxicity	93.7%	3 month dietary; FIFRA 82-1; dose levels: 0, 1, 10, 50, 200 ppm	NOAEL = 7.26 mg/kg bw/d (200 ppm) LOAEL = 17 mg/kg bw/d (500 ppm)	CGA184927/ 0042; 1989
Dog, beagle	Short term toxicity	93.7%	1 year dietary; FIFRA 83-1, OECD 452; dose levels: 0, 10, 100, 500 ppm	NOAEL = 3.3 mg/kg bw/d (100 ppm) LOAEL = 15.2 mg/kg bw/d (500 ppm)	CGA184927/ 0158; 1990

Table B. Toxicology profile of clodinafop-propargyl technical material, based on repeated administration (sub-acute to chronic)

Species	Test	Purity	Duration and conditions or guideline adopted	Result	Reference
Mouse, Tif:MAGf	Carcinogenicity	93.7%	18 months dietary; FIFRA 83-2, OECD 451; dose levels: 0, 1, 10, 100, 250 ppm	No carcinogenic effects relevant for humans; target organ: liver NOAEL = 1.1 mg/kg bw/d (10 pm) LOAEL = 11 mg/kg bw/d (100 ppm)	CGA184927/ 0202; 1992
Rat, Tif:RAIf	Chronic toxicity and carcinogenicity	93.7%	2 year dietary, FIFRA 83-2, OECD 453, 1984; dose levels: 0, 1, 10, 300, 750 ppm	Not carcinogenic; target organ: liver NOAEL = 0.32 mg/kg bw/d (10 ppm) LOAEL = 10.2 mg/kg bw/d (300 ppm)	CGA184927/ 0225; 1992
Rat, Crl:CD(DD)BR	Reproductive toxicity	93.7%	2 generation, dietary; OECD 416, FIFRA 83-4; dose levels: 0, 5, 50, 500, 1000 ppm	No effects on reproductive parameters NOAEL = 4.6 mg/kg bw/d (50 ppm) LOAEL = 44 mg/kg bw/d (500 ppm) NOAEL for reproductive effects >89 mg/kg bw/d (>1000 ppm)	CGA184927/ 0156; 1991
Rat, Ico:OFA SD	Developmental toxicity	93.7%	Gavage feeding; OECD 414, FIFRA 83-3; dose levels: 0, 5, 40, 160 mg/kg bw/day	Not teratogenic NOAEL (maternal and developmental toxicity) = 40 mg/kg bw/d LOAEL = 160 mg/kg bw/d	CGA184927/ 0053; 1989
Rabbit, HyCr	Developmental toxicity	93.7%	Gavage feeding; OECD 414, FIFRA 83-3; dose levels: 0, 5, 25, 125, 175 mg/kg bw/day	Not teratogenic NOAEL (maternal toxicity) = 25mg/kg bw/d NOAEL (developmental toxicity) >125 mg/kg bw/d LOAEL (maternal toxicity) = 125 mg/kg bw/day	CGA184927/ 0054; 1990

Table C. Mutagenicity profile of clodinafop-propargyl technical material, based on *in vitro* and *in vivo* tests

Species	Test	Purity	Conditions and dose levels	Results	Reference
Salmonella/E.coli	Bacterial gene mutation, *in vitro*	93.7%	OECD 471; 0 to 5000 µg/plate, ±S9 activation	Negative	CGA1849 27/0046; 1987
Chinese hamster, V79 cells	Gene mutation *in vitro*	93.7%	OECD 476; -S9 activation: 0 to 500 µg/ml +S9 activation: 0 to 50 µg/ml	Negative	CGA1849 27/0049; 1988
Human lymphocytes	Cytogenetic test *in vitro*	93.7%	OECD 473; -S9 activation: 0 to 850 µg/ml +S9 activation: 0 to 88 µg/ml	Negative	CGA1849 27/0050; 1988

Table C. Mutagenicity profile of clodinafop-propargyl technical material, based on *in vitro* and *in vivo* tests

Species	Test	Purity	Conditions and dose levels	Results	Reference
Chinese hamster cells	Cytogenetic test *in vitro*	93.7%	OECD 473; -S9 activation: 0 to 100 µg/ml +S9 activation: 0 to 50 µg/ml	-S9 negative +S9 positive at highest dose	CGA184927/4720; 2000
Rat hepatocytes	DNA repair *in vitro*	94.2%	OECD 482; 0 to 70 µg/ml	Negative	CGA184927/0047; 1987
Mouse bone marrow cells	Micronucleus test *in vivo*	93.7%	OECD 474; 0, 1667, 5000 mg/kg bw	Negative	CGA184927/0048; 1987
Rat hepatocytes	DNA repair *in vivo/in vitro*	93.7%	OECD 486; 0, 1000, 2000 mg/kg bw	Negative	CGA184927/4678; 1999

A positive response in the chromosome aberration test in Chinese hamster cells *in vitro* occurred only at the highest concentration (with metabolic activation), which was cytotoxic. The effect was considered to be secondary to the cytotoxicity and not of relevance when assessing the overall mutagenic potential of clodinafop-propargyl. An *in vivo* DNA repair study on rat hepatocytes showed no mutagenic potential of clodinafop-propargyl. Thus it was concluded that clodinafop-propargyl is not genotoxic.

Table D. Ecotoxicology profile of clodinafop-propargyl technical material

Species	Test	Purity	Duration and conditions	Results	Reference
Anas platyrhynchos (mallard duck)	Acute oral	93.7%	Observation 14 d; EPA guidelines, E, 1982; doses: 500, 1000, 2000 mg a.s./kg bw	LC_{50} >2000 mg/kg feed NOEL >2000 mg/kg feed	CGA184927/0008; 1990
Colinus virginianus (bobwhite quail)	Acute oral	93.7%	Observation 14 d; EPA guidelines, E, 1982; doses: 500, 1000, 2000 mg a.s./kg bw	LC_{50} >1455 mg/kg feed NOEL 521 mg/kg feed	CGA184927/0009; 1990
Anas platyrhynchos (mallard duck)	Short-term	93.7%	Treatment 5 d, observation 3 d; EPA guidelines, E, 1982; doses: 163, 325, 650, 1300, 2600, 5200 mg/kg feed	LC_{50} >5200 mg/kg feed NOEC = 325 mg/kg feed	CGA184927/0007; 1989
Colinus virginianus (bobwhite quail)	Short-term	93.7%	Treatment 5 d, observation 3 d; EPA guidelines, E, 1982; doses: 163, 325, 650, 1300, 2600, 5200 mg/kg feed	LC_{50} >5200 mg/kg feed NOEC = 1300 mg/kg feed	CGA184927/0061; 1990
Anas platyrhynchos (mallard duck)	Sub-chronic	94.2%	Treatment 24 weeks; age 20 weeks; EPA guidelines, E, 1982; doses 0, 80, 200, 500 mg a.s./kg feed	LLC (lowest lethal concentration) >500 mg/kg feed; NOEC > 500 mg/kg feed	CGA184927/0380; 1993
Colinus virginianus (bobwhite quail)	Sub-chronic	94.2%	Treatment 22 weeks; age: 52 weeks; EPA guidelines, E, 1982; doses 0, 50, 200, 500 mg a.s./kg feed	LLC (lowest lethal concentration) >500 mg/kg feed; NOEC > 500 mg/kg feed	CGA184927/0379; 1993

Table D. Ecotoxicology profile of clodinafop-propargyl technical material

Species	Test	Purity	Duration and conditions	Results	Reference
Oncorhynchus mykiss (rainbow trout)	Short-term	94.7%	96h flow-through; OECD 203, doses 0.15, 0.24, 0.40, 0.67 and 1.1 mg/l	LC_{50} = 0.31-0.39 mg a.s./l NOEC = 0.14-0.22 mg a.s./l	CGA184927/0062; 1989 CGA184927/0681; 1998
Lepomis macrochirus (bluegill sunfish)	Short-term	93.7%	96h flow-through; OECD 203, doses 0.32, 0.58, 1.0, 1.8, 3.2 mg/l	LC_{50} = 0.21 mg a.s./l NOEC < 0.12 mg a.s./l	CGA184927/0162; 1989
Cyprinus carpio (carp)	Short-term	93.7%	96h flow-through; OECD 203; doses 0.18, 0.32, 0.58, 1.0, 1.8 mg/l	LC_{50} = 0.43 mg a.s./l NOEC = 0.12 mg a.s./l	CGA184927/0010; 1989
Ictalurus punctatus (catfish)	Short-term	93.7%	96h flow-through; OECD 203; doses 0.58, 1.0, 1.8, 3.2, 5.8 mg/l	LC_{50} = 0.46 mg a.s./l NOEC = 0.23 mg a.s./l	CGA184927/0011; 1989
Oncorhynchus mykiss (rainbow trout)	Chronic toxicity (juvenile fish)	93.7%	21 days, flow-through ; OECD 204; doses 0.58, 1.0, 1.8, 3.2, 5.8 mg/l	LLC (lowest lethal concentration) 0.28 mg a.s./ l; NOEC = 0.15 mg a.s./ l	CGA184927/0077; 1990
Oncorhynchus mykiss (rainbow trout)	Chronic toxicity	94.2%	21 d, flow-through; OECD 204; doses 0.005, 0.016, 0.05, 0.16, 0.5 mg/l	LLC (lowest lethal concentration) 0.40 mg a.s./ l; NOEC= 0.1 mg a.s./ l	CGA184927/0586; 1996
Daphnia magna (water flea)	Acute	93.7%	Static, 48 h exposure; EPA guideline 1982; doses 10, 18, 32, 58, 100 mg/l	EC_{50} = > 60 mg a.s./l NOEC > 60 mg a.s./l	CGA184927/0012; 1988
Daphnia magna (water flea)	Acute	94.7%	Flow-through, 48 h exposure; EPA guideline 1982; doses 10, 18, 32, 58, 100 mg/l	EC_{50} = >2 mg a.s./l NOEC > 2 mg a.s./l	CGA184927/0682; 1998
Daphnia magna (water flea)	Chronic	93.7%	Static, 48 h exposure; EPA guideline 1982; doses 10, 18, 32, 58, 100 mg/l	EC_{50} = > 60 mg a.s./l NOEC > 60 mg a.s./l	CGA184927/0585; 1996
Scenedesmus subspicatus (green alga)	Growth inhibition	93.7%	3 d; OECD 201; doses 10, 18, 32, 58, 100 mg/l	EC_{50} >62mg a.s./l NOEC >62 mg a.s./l	CGA184927/0013; 1988
Scenedesmus subspicatus (green alga)	Growth inhibition	94.2%	3 d; OECD 201; doses 4.8, 8, 13, 22, 36, 60, 100 mg/l	EC_{50} >6.5mg a.s./l NOEC = 0.47 mg a.s./l	CGA184927/0584; 1996
Selanastrum capricornutum (green alga)	Growth inhibition	94.2%	5 d; EPA guideline 123-2; doses 0.26, 0.50, 1.0, 2.0, 4.0 mg/l	EC_{50} >3.9 mg a.s./l NOEC = 1.7 mg a.s./l	CGA184927/0680; 1998
Anabaena flos-aquae (blue-green alga)	Growth inhibition	94.7%	5 d; EPA 123-2; doses 0.26, 0.50, 1.0, 2.0, 4.0 mg/l	EC_{50} >3.6 mg a.s./l NOEC >3.6 mg a.s./l	CGA184927/0679; 1998
Microcystis aeruginosa (blue-green alga)	Growth inhibition	94.2%	5 d; ASTM Guideline E 1218-90; doses 13, 22, 36, 60, 100 mg/l	EC_{50} >78.1 mg a.s./l NOEC >78.1 mg a.s./l	CGA184927/0278; 1993

Table D. Ecotoxicology profile of clodinafop-propargyl technical material

Species	Test	Purity	Duration and conditions	Results	Reference
Navicula pelliculosa (blue-green alga)	Growth inhibition	94.2%	4 d; ASTM Guideline E 1218-90; doses 13, 22, 36, 60, 100 mg/l	EC_{50} = 12.55 mg a.s./l NOEC = 1.1 mg a.s./l	CGA184927/0280; 1993
Lemna gibba (duckweed)	Growth inhibition	94.2%	14 d; similar to EPA FIFRA guidelines 122-2 and 123-2; nominal dose 4.0 mg/l	EC_{50} = 2.4 mg a.s./l NOEC (reproduction) >2.4 mg a.s./l	CGA184927/0343; 1993
Glyceria maxima	Growth inhibition	24% EC	14 d exposure,14 d recovery; formulation equivalent to doses of 0.024, 0.072, 0.24, 0.72, 2.4 mg a.s./l. No standard test guideline available	EC_{50} = 0.15 mg a.s./l NOEC >0.018 mg a.s./l	CGA184927/4753; 2000
Chironomus riparius (midge)	Emergence rate	93.6%	28 d; OECD test with Chironomidae, 1997; doses 0.5, 1, 2, 4, 8, 16 mg/l nominal	EC_{50} >16 mg a.s./l NOEC >16 mg a.s./l	CGA184927/0684; 1998
Chironomus riparius (midge)	larval develop-ment rate	93.6%	28 d; OECD test with Chironomidae, 1997; doses 0.5, 1, 2, 4, 8, 16 mg/l nominal	EC_{50} >16 mg a.s./l NOEC >16 mg a.s./l	CGA184927/0684; 1998
Apis mellifera (honey bee)	Oral, mortality / behaviour	93.7%	48 h; EPA FIFRA 71-2; limit test at 100 µg/bee	LD_{50} >100 µg a.s./bee NOEC >100 µg a.s./bee	CGA184927/0015; 1987
Apis mellifera (honey bee)	Contact, mortality / behaviour	93.7%	48 h; EPA FIFRA 71-2; limit test at 100 µg/bee	LD_{50} >100 µg a.s/bee NOEC >100 µg a.s/bee	CGA184927/0015; 1987
Eisenia foetida foetida (earthworm)	Acute toxicity, mortality / behaviour	93.7%	14 d; OECD 207; doses 62.5, 125, 250, 500, 1000 mg a.s./kg soil	LC_{50} = 210 mg/kg soil NOEL = 62.5 mg a.s./kg soil	CGA184927/0014; 1988

ANNEX 2. REFERENCES

Syngenta document number or other reference	Year and title of report or publication details
CGA184927/0232	1992 - Vapour pressure
CGA184927/0478	1994 - Melting point
CGA184927/4628	1997 - Boiling point
CGA184927/4628	1997 - Temperature of decomposition
CGA184927/4709	2000
CGA184927/0230	1991 - Solubility in water
CGA184927/0231	1991 - Octanol/water partition coefficient
CGA184927/4851	2001 - Hydrolysis characteristics
CGA184927/0017	1990 - Photolysis characteristics
CGA184927/0234	1991 - Dissociation characteristics
CGA184927/0045	1987 - Acute oral tox rat
CGA184927/0169	1991 - Acute oral tox mouse
CGA184927/0034	1987 - Acute dermal tox
CGA184927/0035	1987 - Acute inhalation
CGA184927/0036	1987 - Skin irritation
CGA184927/0037	1987 - Eye irritation
CGA184927/0039	1987 - Skin sensitization
CGA184927/0041	1989 - Short term toxicity rat
CGA184927/0042	1989 - Short term toxicity dog 3 month
CGA184927/0158	1990 - Short term toxicity 1 year
CGA184927/0202	1992 - Mouse carcinogenicity
CGA184927/0225	1992 - Rat chronic toxicity and carcinogenicity
CGA184927/0156	1991 - Rat reproductive toxicity
CGA184927/0053	1989 - Rat developmental toxicity
CGA184927/0054	1990 - Rabbit developmental toxicity
CGA184927/0046	1987 - Bacterial gene mutation
CGA184927/0049	1988 - CHO gene mutation
CGA184927/0050	1988 - Human lymphocytes cytogenetic test
CGA184927/4720	2000 - CHO cytogenetic test
CGA184927/0047	1987 - Rat hepatocytes DNA repair in vitro
CGA184927/0048	1987 - Mouse micronucleus test
CGA184927/4678	1999 - Rat hepatocytes DNA repair *in vivo/in vitro*
CGA184927/0008	1990 - Acute oral mallard
CGA184927/0009	1990 - Acute oral bobwhite quail
CGA184927/0007	1989 - Short-term tox mallard
CGA184927/0061	1990 - Short-term tox bobwhite quail
CGA184927/0380	1993 - Sub-chronic tox mallard
CGA184927/0379	1993 - Sub-chronic tox bobwhite quail
CGA184927/0062	1989 - Short-term tox rainbow trout
CGA184927/0681	1998
CGA184927/0162	1989 - Short-term tox bluegill sunfish
CGA184927/0010	1989 - Short-term tox carp
CGA184927/0011	1989 - Short-term tox catfish
CGA184927/0077	1990 - Chronic toxicity rainbow trout juvenile
CGA184927/0586	1996 - Chronic toxicity rainbow trout
CGA184927/0012	1988 - Acute tox Daphnia static
CGA184927/0682	1998 - Acute tox Daphnia flow-through

Syngenta document number or other reference	Year and title of report or publication details
CGA184927/0585	1996 - Chronic toxicity Daphnia
CGA184927/0013	1988 - *Scenedesmus* growth inhibition 93.7% purity
CGA184927/0584	1996 - *Scenedesmus* growth inhibition 94.2% purity
CGA184927/0680	1998 - *Selanastrum* growth inhibition
CGA184927/0679	1998 - *Anabaena* growth inhibition
CGA184927/0278	1993 - *Microcystis* growth inhibition
CGA184927/0280	1993 - *Navicula* growth inhibition
CGA184927/0343	1993 - *Lemna* growth inhibition
CGA184927/4753	2000 - *Glyceria* growth inhibition
CGA184927/0684	1998 - *Chironomus* emergence rate
CGA184927/0684	1998 - *Chironomus* larval development rate
CGA184927/0015	1987 - Acute oral tox honey bee
CGA184927/0015	1987 - Acute contact tox honey bee
CGA184927/0014	1987 - Acute tox earthworm
EPA 2000	2000 - Clodinafop-propargyl; pesticide tolerances (EPA-738-F-95-015). *Federal Register*, **65**, No.121, pp.38765-39774, 2000.
EU 2005	2005 - “Conclusion regarding the peer review of the pesticide risk assessment of the active substance Clodinafop”. 10 August, 2005. http://www.efsa.eu.int/science/praper/conclusions/1111_en.html.
FAO/WHO 2006	2006 - Manual on the development and use of FAO and WHO specifications for pesticides, March 2006 revision, internet publication at http://www.fao.org/ag/agp/agpp/pesticid/.