

# FAO SPECIFICATIONS AND EVALUATIONS FOR AGRICULTURAL PESTICIDES

## SPINOSAD

**A mixture of spinosyn A,**

*(2R,3aS,5aR,5bS,9S,13S,14R,16aS,16bR)*-2-(6-deoxy-2,3,4-tri-*O*-methyl- $\alpha$ -L-mannopyranosyloxy)-13-(4-dimethylamino-2,3,4,6-tetra-deoxy- $\beta$ -D-erythro-pyranosyloxy)-9-ethyl-2,3,3a,5a,6,7,9,10,11,12,13,14,15,16a,16b-hexadecahydro-14-methyl-1*H*-8-oxacyclododeca[*b*]as-indacene-7,15-dione,

**and spinosyn D,**

*(2R,3aS,5aR,5bS,9S,13S,14R,16aS,16bR)*-2-(6-deoxy-2,3,4-tri-*O*-methyl- $\alpha$ -L-mannopyranosyloxy)-13-(4-dimethylamino-2,3,4,6-tetra-deoxy- $\beta$ -D-erythro-pyranosyloxy)-9-ethyl-2,3,3a,5a,6,7,9,10,11,12,13,14,15,16a,16b-hexadecahydro-4,14-dimethyl-1*H*-8-oxacyclododeca[*b*]as-indacene-7,15-dione,

**with spinosyns A:D proportions in the range 50:50 to 95:5**



FOOD AND AGRICULTURE ORGANIZATION *of* THE UNITED NATIONS

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## DISCLAIMER<sup>1</sup>

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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.

FAO disclaims any and all liability for any injury, death, loss, damage or other prejudice of any kind that may arise as a result of, or in connection with, the manufacture, sale, transportation, storage, handling, preparation and/or use of pesticides which are found, or are claimed, to have been manufactured to comply with these specifications.

Additionally, FAO 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.

FAO 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, FAO does not in any way warrant or represent that any pesticide claimed to comply with a FAO specification actually does so.

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<sup>1</sup> This disclaimer applies to all specifications published by FAO.

## INTRODUCTION

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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 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) and amended with the supplement of this manual (2006), 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 JMPS, rather than the JMPS.]

FAO Specifications now only apply to products for which the technical materials have been evaluated. Consequently from the year 2000 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 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. 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.**

\* NOTE: PUBLICATIONS ARE AVAILABLE ON THE INTERNET AT  
(<http://www.fao.org/ag/agp/agpp/pesticid/>)

OR IN HARDCOPY FROM THE PLANT PROTECTION INFORMATION OFFICER.

**PART ONE**  
**SPECIFICATIONS**

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SPINOSAD

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## SPINOSAD

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### INFORMATION

*ISO common name*

Spinosad (BSI, E-ISO, ANSI), being a mixture of spinosyns A and D, with A:D proportions in the range 50:50 to 95:5

*Synonyms*

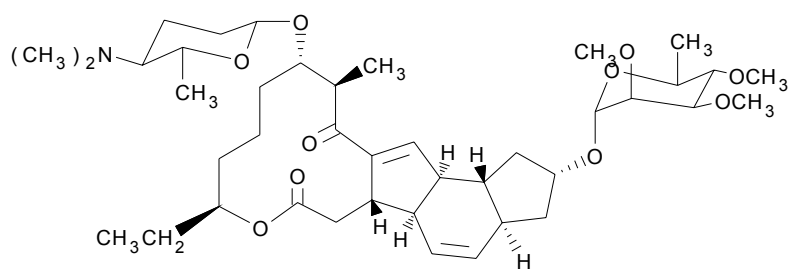
None

*Chemical names*

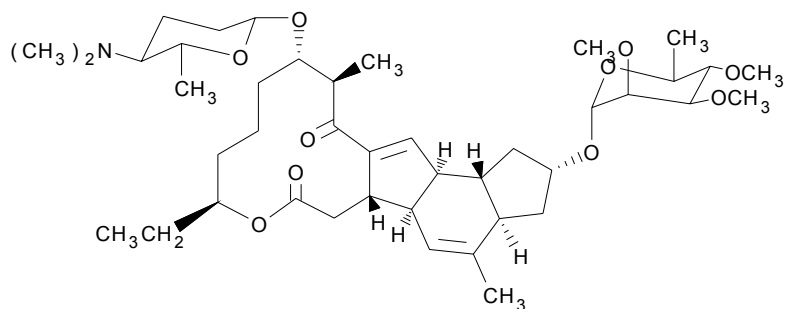
*IUPAC* A mixture of spinosyn A,  
(2*R*,3*aS*,5*aR*,5*bS*,9*S*,13*S*,14*R*,16*aS*,16*bR*)-2-(6-deoxy-2,3,4-tri-*O*-methyl- $\alpha$ -L-mannopyranosyloxy)-13-(4-dimethylamino-2,3,4,6-tetra-deoxy- $\beta$ -D-erythro-pyranosyloxy)-9-ethyl-2,3,3*a*,5*a*,6,7,9,10,11,12,13,14,15,16*a*,16*b*-hexadecahydro-14-methyl-1*H*-8-oxacyclododeca[*b*]as-indacene-7,15-dione,  
and spinosyn D,  
(2*R*,3*aS*,5*aR*,5*bS*,9*S*,13*S*,14*R*,16*aS*,16*bR*)-2-(6-deoxy-2,3,4-tri-*O*-methyl- $\alpha$ -L-mannopyranosyloxy)-13-(4-dimethylamino-2,3,4,6-tetra-deoxy- $\beta$ -D-erythro-pyranosyloxy)-9-ethyl-2,3,3*a*,5*a*,6,7,9,10,11,12,13,14,15,16*a*,16*b*-hexadecahydro-4,14-dimethyl-1*H*-8-oxacyclododeca[*b*]as-indacene-7,15-dione,  
with A:D proportions in the range 50:50 to 95:5

*CA* [2*R*-[2*R*<sup>\*</sup>,3*aS*<sup>\*</sup>,5*aR*<sup>\*</sup>,5*bS*<sup>\*</sup>,9*S*<sup>\*</sup>,13*S*<sup>\*</sup>(2*R*<sup>\*</sup>,5*S*<sup>\*</sup>,6*R*<sup>\*</sup>),14*R*<sup>\*</sup>,16*aS*<sup>\*</sup>,16*bR*<sup>\*</sup>]]-2-[(6-deoxy-2,3,4-tri-*O*-methyl- $\alpha$ -L-mannopyranosyl)oxy]-13-[[5-(dimethylamino)tetrahydro-6-methyl-2*H*-pyran-2-yl]oxy]-9-ethyl-2,3,3*a*,5*a*,5*b*,6,9,10,11,12,13,14,16*a*,16*b*-tetradecahydro-14-methyl-1*H*-as-indaceno(3,2-*d*)oxacyclododecin-7,15-dione (spinosyn A),  
mixture with  
[2*S*-[2*R*<sup>\*</sup>,3*aS*<sup>\*</sup>,5*aR*<sup>\*</sup>,5*bR*<sup>\*</sup>,9*R*<sup>\*</sup>,13*R*<sup>\*</sup>(2*S*<sup>\*</sup>,5*R*<sup>\*</sup>,6*S*<sup>\*</sup>),14*S*<sup>\*</sup>,16*aR*<sup>\*</sup>,16*bR*<sup>\*</sup>]]-2-[(6-deoxy-2,3,4-tri-*O*-methyl- $\alpha$ -L-mannopyranosyl)oxy]-13-[[5-(dimethylamino)tetrahydro-6-methyl-2*H*-pyran-2-yl]oxy]-9-ethyl-2,3,3*a*,5*a*,5*b*,6,9,10,11,12,13,14,16*a*,16*b*-tetradecahydro-4,14-dimethyl-1*H*-as-indaceno(3,2-*d*)oxacyclododecin-7,15-dione (spinosyn D)

*Structural formulae*



spinosyn A



spinosyn D

*Empirical formulae*

spinosyn A: C<sub>41</sub>H<sub>65</sub>NO<sub>10</sub>

spinosyn D: C<sub>42</sub>H<sub>67</sub>NO<sub>10</sub>

*Relative molecular mass*

spinosyn A: 732.0

spinosyn D: 746.0

*CAS Registry number*

spinosyn A: 131929-60-7

spinosyn D: 131929-63-0

*CIPAC number*

636

*EEC number*

434-300-1

*Identity tests*

HPLC retention time, positive-ion ESI LC-MS.

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## SPINOSAD TECHNICAL MATERIAL

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### FAO specification 636/TC (January 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 (636/2005). 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 (636/2005) as PART TWO forms an integral part of this publication.*

#### 1 Description

The material shall consist of spinosad together with related manufacturing impurities and shall be a grey/white to tan coloured powdery material, free from visible extraneous matter and added modifying agents.

#### 2 Active ingredient

##### 2.1 Identity tests (636/TC/M/2, CIPAC Handbook L, Note 1)

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 Spinosad content (636/TC/M/3, CIPAC Handbook L, Note 1)

The spinosad (spinosyn A + spinosyn D) content shall be declared (not less than 850 g/kg) and, when determined, the average measured content shall not be lower than the declared minimum content.

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**Note 1** Methods for the identification and determination of spinosad content were adopted by CIPAC in 2005 but are not yet published in a Handbook. Prior to publication of the Handbook, copies of the methods 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](mailto:bura.laszlo@ntks.ontsz.hu)).

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\* Specifications may be revised and/or additional evaluations may be undertaken. Ensure the use of current versions by checking at: <http://www.fao.org/ag/agp/agpp/pesticid/>.



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## SPINOSAD GRANULES

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### FAO specification 636/GR (January 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 (636/2005). 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 (636/2005) as PART TWO forms an integral part of this publication.*

## 1 Description

The material shall consist of granules containing technical spinosad, complying with the requirements of the FAO specification 636/TC (January 2006), together with suitable carriers and any other necessary formulants. The granules shall be free from visible extraneous matter and hard lumps, free-flowing, essentially non-dusty and intended for application by machine.

## 2 Active ingredient

### 2.1 Identity tests (636/GR/M/2, CIPAC Handbook L, Note 1)

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 Spinosad content (636/GR/M/3, CIPAC Handbook L, Note 1)

The spinosad (spinosyn A + spinosyn D) content shall be declared (g/kg) and, when determined, the average measured content shall not differ from that declared by more than the following tolerances:

Declared content, g/kg	Tolerance
up to 25	± 10% of the declared content
Note: the upper limit is included in the range	

## 3 Physical properties

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

Pour density: 0.47 to 0.61 g/ml.

Tap density: 0.52 to 0.66 g/ml.

### 3.2 Nominal size range (MT 58, CIPAC Handbook F, p.173, 1995) (Note 2)

Not less than 850 g/kg of the formulation shall be within the size range 1100 to 1600 µm.

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\* Specifications may be revised and/or additional evaluations may be undertaken. Ensure the use of current versions by checking at: <http://www.fao.org/ag/agp/agpp/pesticid/>.

**3.3 Dustiness** (MT 171, CIPAC Handbook F, p.425, 1995)

Essentially non-dusty (Note 3).

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

Minimum: 98% attrition resistance.

**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 average content found before storage (Note 4) and the formulation shall continue to comply with the clauses for:

- nominal size range (3.2),
- dustiness (3.3),
- attrition resistance (3.4).

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Note 1 Methods for the identification and determination of spinosad content were adopted by CIPAC in 2005 but are not yet published in a Handbook. Prior to publication of the Handbook, copies of the methods 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@ntkasz.ontsz.hu](mailto:bura.laszlo@ntkasz.ontsz.hu)).

Note 2 Higher ratios increase the risk of segregation and adverse effects on the flow rate. This should be checked with the machine to be used. The purchaser should check that the nominal size range is suitable for his requirements, since different size ranges may affect biological activity.

Note 3 The optical method, MT 171, usually shows good correlation with the gravimetric method 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 case of dispute the gravimetric method shall be used.

Note 4 Samples of the formulation taken before and after the storage stability test should be analyzed together after the test in order to reduce the analytical error.

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## SPINOSAD AQUEOUS SUSPENSION CONCENTRATE

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### FAO specification 636/SC (January 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 (636/2005). 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 (636/2005) as PART TWO forms an integral part of this publication.*

## 1 Description

The material shall consist of a suspension of fine particles of technical spinosad complying with the requirements of FAO specification 636/TC (January 2006), in an aqueous phase together with suitable formulants. After gentle agitation the material shall be homogeneous (Note 1) and suitable for further dilution in water.

## 2 Active ingredient

### 2.1 Identity tests (636/SC/M/2, CIPAC Handbook L, Note 2)

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 Spinosad content (636/SC/M/3, CIPAC Handbook L, Note 2)

The spinosad (spinosyn A + spinosyn D) content shall be declared (g/kg or g/l at  $20 \pm 2^\circ\text{C}$ , Note 3) and, when determined, the average content measured shall not differ from that declared by more than the following tolerance:

Declared content, g/kg or g/l at $20 \pm 2^\circ\text{C}$	Tolerance
above 100 up to 250	$\pm 6\%$ of the declared content
above 250 up to 500	$\pm 5\%$ 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)

pH range: 6.5 to 8.5.

### 3.2 Pourability (MT 148.1, CIPAC Handbook J, p.133, 2000)

Maximum "residue": 5%.

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\* Specifications may be revised and/or additional evaluations may be undertaken. Ensure the use of current versions by checking at: <http://www.fao.org/ag/agp/agpp/pesticid/>.

**3.3 Spontaneity of dispersion** (MT 160, CIPAC Handbook F, p.391, 1995)  
(Note 4)

A minimum of 75% of the spinosad content found under 2.2 shall be in suspension after 5 min in CIPAC Standard Water D at  $30 \pm 2^\circ\text{C}$ .

**3.4 Suspensibility** (MT 184, CIPAC Handbook K, p.142, 2003) (Note 4)

A minimum of 70% of the spinosad content found under 2.2 shall be in suspension after 30 min in CIPAC Standard Water D at  $30 \pm 2^\circ\text{C}$ .

**3.5 Wet sieve test** (MT 185, CIPAC Handbook K, p.148, 2003) (Note 5)

Maximum: 0.5% of the formulation shall be retained on a 75  $\mu\text{m}$  test sieve.

**3.6 Persistent foam** (MT 47.2, CIPAC Handbook F, p.152, 1995) (Note 6)

Maximum: 20 ml after 1 min.

#### **4 Storage stability**

**4.1 Stability at  $0^\circ\text{C}$**  (MT 39.3, CIPAC Handbook J, p.126, 2000)

After storage at  $0 \pm 2^\circ\text{C}$  for 7 days, the formulation shall continue to comply with the clauses for:

- suspensibility (3.4);
- wet sieve test (3.5).

**4.2 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 7) and the formulation shall continue to comply with the clauses for:

- pH range (3.1),
- pourability (3.2),
- spontaneity of dispersion (3.3),
- suspensibility (3.4),
- wet sieve test (3.5).

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Note 1 Before sampling to verify the formulation quality, inspect the commercial container carefully. On standing, suspension concentrates usually develop a concentration gradient from the top to the bottom of the container. This may even result in the appearance of a clear liquid on the top and/or of sediment on the bottom. Therefore, before sampling, homogenize the formulation according to the instructions given by the manufacturer or, in the absence of such instructions, by gentle shaking of the commercial container (for example by inverting the closed container several times). Large containers must be opened and stirred adequately. After this procedure, the container should not contain a sticky layer of non-dispersed matter at the bottom. A suitable and simple method of checking for a non-dispersed sticky layer "cake" is by probing with a glass rod or similar device adapted to the size and shape of the container. All the physical and chemical tests must be carried out on a laboratory sample taken after the recommended homogenization procedure.

Note 2 Methods for the identification and determination of spinosad content were adopted by CIPAC in 2005 but are not yet published in a Handbook. Prior to publication of the Handbook, copies of the methods 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@ntkszh.ontsz.hu).

- Note 3 Unless homogenization is carried out carefully, it is possible for the sample to become aerated. This can lead to errors in the determination of the mass per millilitre and in calculation of the active ingredient content (in g/l) if methods other than MT 3.3 are used. 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 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 and solvent extraction determination may be used on a routine basis provided that these methods have been shown to give equal results to those of the chemical assay method. In case of dispute, the chemical method shall be the referee method.
- Note 5 This test detects coarse particles (e.g. caused by crystal growth) or agglomerates (crust formation) or extraneous materials which could cause blockage of spray nozzles or filters in the spray tank.
- Note 6 The mass of sample to be used in the test should be specified at the application rate of use recommended by the supplier.
- Note 7 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.

## PART TWO

### EVALUATION REPORTS

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#### SPINOSAD

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## SPINOSAD

### EVALUATION REPORT 636/2007

#### Recommendations

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The Meeting recommended that the specification for spinosad DT, proposed by Dow AgroSciences, as amended, should be adopted by WHO, subject to satisfactory evaluation of these products in public health applications by WHOPES<sup>1</sup>.

#### Appraisal

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Supporting data and draft specifications for spinosad DT, provided by Dow AgroSciences, were considered by the JMPS for development of a new WHO specification. Spinosad DT is intended only for mosquito larviciding and the specification is, therefore, restricted to WHO.

Each tablet consists of two homogenous horizontal layers of technical spinosad. An upper layer consists of technical spinosad in an effervescent system providing fast release of active ingredient upon application to water, whereas the lower layer is formulated to dissolve in water gradually over time. The tablets are vacuum-packed in a resealable moisture-barrier pouch.

The proposed specification for DT was broadly in agreement with the guidelines given in the manual<sup>2</sup>. The manufacturer presented supporting information on the release of spinosad from the DT formulation into 200-litre water volumes, showing an initial fast release due to the dissolution of the effervescent layer followed by a slow release of additional active ingredient over prolonged time from the second layer. The Meeting considered the necessity for a release rate clause. However, instead of such a clause, a brief description of the dissolution characteristics was added in Note 1 of the specification, providing information on the two-phase delivery of spinosad to treated water.

The method of analysis of spinosad DT was accepted as a full CIPAC method in 2007, with the identity tests being the same as those for the TC, published in CIPAC Handbook L. The tolerance for the average content of spinosad is with  $\pm 10\%$  in line with the manual for a nominal content of 74.8 g/kg. The manufacturer proposed a maximum 10% relative standard deviation for the tablet dose uniformity, which was accepted by the Meeting.

Clauses for relevant impurities and acidity/alkalinity were unnecessary. There are no relevant impurities in spinosad and, due to the effervescent system, a clause for acidity/alkalinity is not meaningful. The accelerated storage test used was CIPAC MT 46.3, sub-method 2 (no pressure applied). This was accepted by the Meeting, as tablets may suffer from pressure exerted and the subsequent tests of physical properties after storage (tablet integrity and attrition resistance) are prone to

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<sup>1</sup> The WHOPES Working Group reviewed and recommended spinosad 7.48% DT for mosquito larviciding in 2007.

<sup>2</sup> Manual on development and use of FAO and WHO specifications for pesticides. March 2006 revision of the 1<sup>st</sup> edition. Available only on the internet at <http://www.fao.org/ag/agp/agpp/pesticid/> and <http://www.who.int/whopes/quality/>.

artefact formation. As the tablets are vacuum-packed within a robust flexible pouch (containing 250 tablets) which minimizes movement and potential compression of tablets, this was considered acceptable. With this form of packaging, and with one half of the tablet containing an effervescent system to initiate disintegration after application to water, the clause and limit for tablet integrity were considered to be sufficient without the need for the specification to include a test of tablet hardness.



## SPINOSAD

### FAO/WHO EVALUATION REPORT 636/2005

#### Recommendations

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The Meeting recommended that:

- (i) the specifications for spinosad TC, SC and GR, proposed by Dow AgroSciences, should be adopted by FAO;
- (ii) the specifications for spinosad TC, SC and GR, proposed by Dow AgroSciences, should be adopted by WHO, subject to satisfactory evaluation of these products in public health applications by WHOPES.

#### Appraisal

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The Meeting considered data and draft specifications for spinosad, submitted by Dow AgroSciences in 2004. Spinosad is a macrocyclic lactone insecticide that had not previously been the subject of a WHO or FAO specification. The data submitted were in accordance with the requirements of the manual (FAO/WHO 2002) and supported the proposed FAO and WHO specifications for TC, SC and GR.

The spinosad toxicology was evaluated by the FAO/WHO JMPR in 2001 (JMPR 2001). Spinosad residues data were evaluated by the FAO/WHO JMPR in 2001 (JMPR, 2001) and there are currently several Codex maximum residue limits (MRLs) for spinosad. Spinosad was reviewed and approved by the U.S. EPA in 1997 and subsequent regulatory reviews and approvals have occurred in more than 60 countries including Australia, Brazil, Canada, India, Japan, New Zealand and South Africa. Spinosad has been under evaluation by the European Commission as a new active substance since 2000 and EU member state evaluations and provisional approvals have occurred in the Netherlands, Spain and the UK. Spinosad SC and GR formulations are under development as mosquito larvicides and are currently being evaluated by WHOPES, with a report expected in 2006.

Spinosad is under patent in some countries (Australia, Japan, UK), until December 2009, and in the country of technical product manufacture (USA), until March 2015.

The ISO common name, spinosad, denotes an insecticide consisting of two components, called spinosyns A and D (which may be referred to simply as A and D, below). The spinosyns are produced by a soil bacterium, *Saccharopolyspora spinosa*, belonging to the group Actinomycetes, a large group of gram-positive filamentous or branching bacilli.

Spinosad is produced in a fermentation process, where it is obtained by extraction and purification of the whole broth. Spinosyns A and D are present in the isolated spinosad, in proportions of 65-95% and 5-35%, respectively, together with traces of spinosyn-related compounds and other materials derived from the fermentation and purification process. The specified proportions of spinosyns A and D in spinosad are in agreement with the definition of the ISO common name.

The two main spinosyns, A and D, are closely related structurally and represent more than 85% of technical spinosad and are responsible for most of its insecticidal activity. They differ only in the presence of an additional methyl group attached to the bridging carbon of the indacene moiety in spinosyn D. Spinosyns A and D are relatively high molecular weight compounds (732 and 746, respectively). The additional methyl group has a significant effect on certain properties and many of the physico-chemical data were generated using separated and purified A and D.

Spinosyns A and D have very low vapour pressures, making them essentially non-volatile. Spinosyns A and D are weak bases, with  $pK_a$ s of 8.1 and 7.9, respectively. Spinosyn A has a rather low, and pH-dependent, water solubility (290 mg/l at pH 5), with that of D even lower (29 mg/l at pH 5). As may be expected for weak bases, the water solubility decreases with increasing pH in both cases. The octanol/water partition coefficient is also pH-dependent, 2.8 and 3.2 at pH 7, expressed as  $\log P K_{ow}$  for A and D, respectively, with increasing  $\log P K_{ow}$  with increasing pH. Both spinosyns are resistant to hydrolysis in sterile, buffered water, with no detectable hydrolysis at pH 5 and increasing but very slow hydrolysis at pH 7 and 9. Aqueous photolysis of A and D at pH 7 was rapid with a half-life of less than one day.

The Meeting was provided with commercially confidential information on the manufacturing process and 7-batch analysis data on purity and all impurities  $\geq 1$  g/kg. The Meeting noted that, although technical spinosad is of biological origin, the unaccountable fraction was 20 g/kg or less in all batches and that the data supported the proposed minimum active ingredient content of 850 g/kg. These data were confirmed as identical to those submitted for registration in Switzerland. One of the 7 batches, with a slightly higher content of D and an average content of the minor spinosyns, was utilized for the toxicity testing.

The Meeting agreed with the manufacturer that none of the impurities should be considered as relevant.

Analytical methods to determine spinosyns A and D in TC, SC and GR were adopted by CIPAC in 2005. Spinosyns A and D are determined by reversed-phase HPLC with a methanol/acetonitrile/water/acetic acid mobile phase and UV detection. The identity test is based on HPLC-separation of spinosyns A and D and detection by positive ion ESI-MS. The test is highly specific, involving comparison of the retention times of A and D in the HPLC-chromatogram, together with the mass spectra of A and D, showing proton- and sodium adducts and fragmentation.

Draft specifications were submitted for spinosad TC, SC and GR.

At the time of the meeting, the general distinction between TC and TK was still under discussion with industry, although a cut-off value for purity of 900 g/kg had been used as one criterion by the JMPS. The distinction is important because TK specifications have an upper limit for active ingredient content and TC specifications do not. The rationale has been to encourage production of TCs with the highest possible purity, because the maximum possible increase in hazard due to the active ingredient cannot exceed 10% (taken to represent a negligible increase), whereas the consequent proportional reduction in impurity levels may be very significant. This approach cannot be adopted for TK, because the maximum increase in hazard due active ingredient could exceed the 10% threshold.

On this basis, therefore, the proposed minimum content of spinosad in the technical grade active ingredient (850 g/kg) might be considered to represent a TK. The

Meeting noted that the hazards presented by spinosyns A and D are similar and therefore potential changes in their proportions do not affect the decision as to whether technical spinosad is a TC or a TK. Taking into account the manufacturing process, the nature of the impurities and the minimum content of the active ingredient, the Meeting considered that it was not necessary to introduce an upper limit for spinosad content and agreed that, exceptionally, technical spinosad should be considered to be a TC, rather than a TK.

The proportions of spinosyns A and D in technical spinosad TC were confirmed to be in agreement with the ISO definition of the spinosad common name and therefore it was not necessary to introduce a clause specifying the range of ratios.

The proposed specification for SC conformed to the guideline presented in the manual (FAO/WHO 2002) and was supported by the data held by the registration authorities in Switzerland.

The proposed specification for GR differed from the guideline given in the manual, in that the  $\pm 10\%$  tolerance for a.i. content was narrower than the  $\pm 15\%$  maximum. The manufacturer confirmed the proposed tolerance of  $\pm 10\%$  for the 10 g/kg GR formulation was always met in practice and the Meeting agreed to accept it.

**SUPPORTING INFORMATION  
FOR  
EVALUATION REPORT 636/2005**

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## Uses

Spinosad is an insecticide, used for the control of caterpillars, thrips, beetle and fly pests in a range of fruit and vegetable crops, ornamentals, turf, and stored grains. Spinosad has contact activity on all life stages of insects, including eggs, larvae and adults. Eggs must be sprayed directly but larvae and adults can be effectively dosed through contact with treated surfaces. Spinosad is most effective when ingested. Foliar applications are not highly systemic, although trans-laminar activity is evident in certain vegetable crops and ornamental plants. Spinosad acts by altering the function of nicotinic- and GABA-gated ion channels of insect nervous systems but it does not interact with known binding sites for other nicotinic- or GABA-agonistic insecticides. It is used in agriculture, horticulture, forestry, and public health against a wide range of insects including thrips, Mediterranean fruit fly, olive fruit fly, codling moth, caterpillars, leaf miners, Colorado beetle and potato worm (Sparks *et al.* 1998).

## Identity of the active ingredient

### ISO common name

Spinosad (BSI, E-ISO, ANSI), being a mixture of spinosyns A and D, with A:D proportions in the range 50:50 to 95:5

### Synonyms

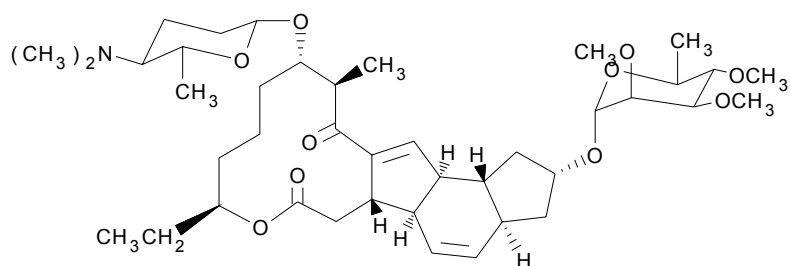
None

### Chemical names

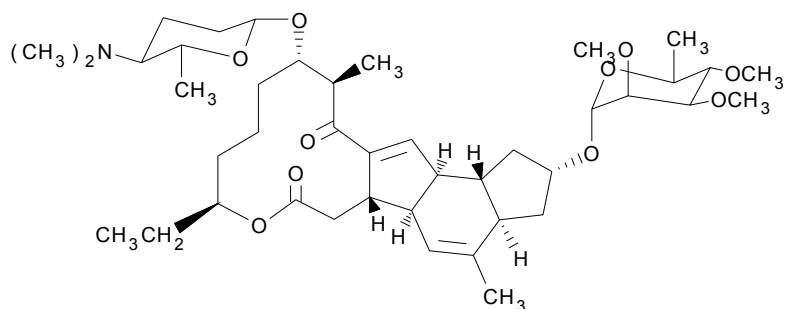
**IUPAC** A mixture of spinosyn A,  
(2*R*,3*aS*,5*aR*,5*bS*,9*S*,13*S*,14*R*,16*aS*,16*bR*)-2-(6-deoxy-2,3,4-tri-*O*-methyl- $\alpha$ -L-mannopyranosyloxy)-13-(4-dimethylamino-2,3,4,6-tetra-deoxy- $\beta$ -D-erythro-pyranosyloxy)-9-ethyl-2,3,3*a*,5*a*,6,7,9,10,11,12,13,14,15,16*a*,16*b*-hexadecahydro-14-methyl-1*H*-8-oxacyclododeca[*b*]as-indacene-7,15-dione,  
and spinosyn D,  
(2*R*,3*aS*,5*aR*,5*bS*,9*S*,13*S*,14*R*,16*aS*,16*bR*)-2-(6-deoxy-2,3,4-tri-*O*-methyl- $\alpha$ -L-mannopyranosyloxy)-13-(4-dimethylamino-2,3,4,6-tetra-deoxy- $\beta$ -D-erythro-pyranosyloxy)-9-ethyl-2,3,3*a*,5*a*,6,7,9,10,11,12,13,14,15,16*a*,16*b*-hexadecahydro-4,14-dimethyl-1*H*-8-oxacyclododeca[*b*]as-indacene-7,15-dione,  
with A:D proportions in the range 50:50 to 95:5

**CA** [2*R*-[2*R*<sup>\*</sup>,3*aS*<sup>\*</sup>,5*aR*<sup>\*</sup>,5*bS*<sup>\*</sup>,9*S*<sup>\*</sup>,13*S*<sup>\*</sup>(2*R*<sup>\*</sup>,5*S*<sup>\*</sup>,6*R*<sup>\*</sup>),14*R*<sup>\*</sup>,16*aS*<sup>\*</sup>,16*bR*<sup>\*</sup>]]-2-[(6-deoxy-2,3,4-tri-*O*-methyl- $\alpha$ -L-mannopyranosyl)oxy]-13-[[5-(dimethylamino)tetrahydro-6-methyl-2*H*-pyran-2-yl]oxy]-9-ethyl-2,3,3*a*,5*a*,5*b*,6,9,10,11,12,13,14,16*a*,16*b*-tetradecahydro-14-methyl-1*H*-as-indaceno(3,2-*d*)oxacyclododecin-7,15-dione (spinosyn A), mixture with  
[2*S*-[2*R*<sup>\*</sup>,3*aS*<sup>\*</sup>,5*aR*<sup>\*</sup>,5*bR*<sup>\*</sup>,9*R*<sup>\*</sup>,13*R*<sup>\*</sup>(2*S*<sup>\*</sup>,5*R*<sup>\*</sup>,6*S*<sup>\*</sup>),14*S*<sup>\*</sup>,16*aR*<sup>\*</sup>,16*bR*<sup>\*</sup>]]-2-[(6-deoxy-2,3,4-tri-*O*-methyl- $\alpha$ -L-mannopyranosyl)oxy]-13-[[5-(dimethylamino)tetrahydro-6-methyl-2*H*-pyran-2-yl]oxy]-9-ethyl-2,3,3*a*,5*a*,5*b*,6,9,10,11,12,13,14,16*a*,16*b*-tetradecahydro-4,14-dimethyl-1*H*-as-indaceno(3,2-*d*)oxacyclododecin-7,15-dione (spinosyn D)

*Structural formulae*



spinosyn A



spinosyn D

*Empirical formulae*

spinosyn A:  $C_{41}H_{65}NO_{10}$

spinosyn D:  $C_{42}H_{67}NO_{10}$

*Relative molecular mass*

spinosyn A: 732.0

spinosyn D: 746.0

*CAS Registry number*

spinosyn A: 131929-60-7

spinosyn D: 131929-63-0

*CIPAC number*

636

*EEC number*

434-300-1

*Identity tests*

HPLC retention time, positive-ion ESI LC-MS.

## Physico-chemical properties of spinosad

**Table 1. Physico-chemical properties of pure spinosad**

Parameter	Value(s) and conditions	Purity %	Method	References
Vapour pressure, at 25°C	Spinosyn A 3.0 x 10 <sup>-8</sup> Pa Spinosyn D 2.0 x 10 <sup>-8</sup> Pa	99.9  >99	OECD No. 104 EEC method A4, Knudsen- effusion/weight loss method	DAS A01, DAS A36
Melting point	Spinosyn A 84 to 99.5°C Spinosyn D 161.5 to 170°C Spinosyn A + D 110 to 123°C	98.3  98.0  88.0 (A+D)	OECD No. 102 EEC method A1	DAS A03
Temperature of decomposition	Decomposition start temperature: 172°C , 92% weight loss during heating to 400°C	88.0 (A+D)	Thermal analysis	DAS A18
Solubility in water, at 20°C	Spinosyn A 290 mg/l at pH 5 235 mg/l at pH 7 16 mg/l at pH 9  Spinosyn D 28.7 mg/l at pH 5 0.332 mg/l at pH 7 0.053 mg/l at pH 9	98.3    99.9  99.8	OECD No. 105: flask method  column elution method column elution method	DAS A20, DAS A37
Octanol/water partition coefficient, at 23°C	Spinosyn A Log P K <sub>ow</sub> = 2.78 at pH 5 Log P K <sub>ow</sub> = 4.01 at pH 7 Log P K <sub>ow</sub> = 5.16 at pH 9 Spinosyn D Log P K <sub>ow</sub> = 3.23 at pH 5 Log P K <sub>ow</sub> = 4.53 at pH 7 Log P K <sub>ow</sub> = 5.21 at pH 9	97.0   98.0	EPA/FIFRA subdiv. D 63.11, shake flask method	DAS A08, DAS A47
Hydrolysis characteristics, at 25°C	Spinosyn A No hydrolysis at pH 5 Half-life = 648 d. at pH 7 Half-life = 200 d. at pH 9 Spinosyn D No hydrolysis at pH 5 and 7 Half-life = 259 d. at pH 9	99.9   99.9	FIFRA guideline 161-1	DAS K05
Photolysis characteristics	Spinosyn A Half-life in dilute aqueous buffer calculated as 0.96 d. in summer sunlight (June-July, Greenfield, Indiana, 39.8°N) Spinosyn D Half-life in dilute aqueous buffer calculated as 0.84 d. in summer sunlight (June-July, Greenfield, Indiana, 39.8°N).	94.7  93.6	FIFRA Guideline 161-2	DAS K06

**Table 1. Physico-chemical properties of pure spinosad**

Parameter	Value(s) and conditions	Purity %	Method	References
Dissociation characteristics, at 20°C	Spinosyn A pKa = 8.1 Ka = 7.94 x 10 <sup>-9</sup>	97.0	OECD guideline 112, capillary electrophoresis method	DAS A04, DAS A07
	Spinosyn D pKa = 7.87 Ka = 1.35 x 10 <sup>-8</sup>	97.0		

**Table 2. Chemical composition and properties of technical spinosad (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 98.0-101.6%, maximum percentage of unknowns was 0.3%.
Declared minimum spinosad content	850 g/kg (spinosyn A + spinosyn D)
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
Melting temperature of the TC	110 to 123°C, (spinosyn A + spinosyn D)

### **Background information on toxicology/ecotoxicology**

Dow AgroSciences confirmed that the toxicological and ecotoxicological data included in Annex 1, below, were derived from spinosad having impurity profiles similar to those referred to in Table 2, above.

Spinosad was evaluated for toxicology by the FAO/WHO JMPR in 2001. The JMPR concluded that spinosad has low acute toxicity. In studies with repeated doses, no acute toxicological alerts were observed that might indicate the need for establishing an acute reference dose (acute RfD). An ADI of 0–0.02 mg/kg bw was established on the basis of a NOAEL of 2.4 mg/kg bw per day in a 2-year study of toxicity and carcinogenicity in rats (Bond *et al.* 1995b, 1996d) and a 100-fold safety factor. The Swiss authorities assigned an ADI of 0-0.02 mg/kg bw/d, based on a NOEL of 2.4 mg/kg bw/d in the two year study on rats. This range is in agreement with the ADI assigned by the JMPR. The JMPR concluded that it was not necessary to assign an acute reference dose.

Maximum residue limits for spinosad have been set in Switzerland for a range of agricultural commodities. Estimated dietary intakes, based on typical food baskets, indicate that exposure of the population is expected to be well below the ADI.

The WHO hazard classification of spinosad is U, unlikely to present acute hazard in normal use (WHO 2004).

### **Formulations**

The main formulation types available are suspension concentrates (SC) at 120 to 480 g spinosad/l, wettable powders (WP), water dispersible granules (WG), and



granules for direct application (GR). Spinosad may be co-formulated with other insecticide active ingredients.

The formulations are registered and sold in more than 60 countries throughout the world including the USA, Australia, Brazil, Canada, India, Japan, New Zealand, Switzerland and South Africa. Spinosad has been under EU evaluation as a new active substance since 2000, and meanwhile member state evaluations and provisional approvals have been granted in a number of EU countries including Italy, Netherlands, Spain, and the UK.

### **Methods of analysis and testing**

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Analytical methods for the identification and determination of spinosad content were adopted by CIPAC in 2005. The spinosad content (sum of spinosyns A and D) is determined by reversed-phase HPLC, using UV detection at 280 nm and external standardization. Definitive identification is by positive-ion ESI LC-MS, as no other technique is sufficiently specific.

Methods for the determination of impurities are based on reversed-phase HPLC with UV detection.

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

### **Physical properties**

The physical properties of the SC and GR formulations, the test methods and specification limits proposed, comply with the requirements of the manual (FAO/WHO 2002).

### **Containers and packaging**

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No special requirements for containers and packaging have been identified.

### **Expression of active ingredient**

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The active ingredient is expressed as spinosad, which is the sum of spinosyn A + spinosyn D, in g/kg or g/l at  $20 \pm 2^\circ\text{C}$ .

## ANNEX 1

### HAZARD SUMMARY PROVIDED BY THE PROPOSER

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

**Table A. Toxicology profile of the spinosad technical material\*, based on acute toxicity, irritation and sensitization**

Species	Test	Duration and conditions	Result	References
Rat, m & f	Acute oral	OECD guideline 401 acute oral toxicity, 1987	LD <sub>50</sub> ≥ 3738 mg/kg bw (m) LD <sub>50</sub> > 5000 mg/kg bw (f)	DAS B01, DAS B16
Mouse, m & f	Acute oral	OECD guideline 401 acute oral toxicity, 1987	LD <sub>50</sub> >5000 mg/kg bw (m & f)	DAS B01, DAS B16
Rabbit, m & f	Acute dermal	OECD guideline 402 acute dermal toxicity, 1987	LD <sub>50</sub> >5000 mg/kg bw (m & f)	DAS B07
Rat, m & f	Acute inhalation	EC test guideline (EC method B.2 acute toxicity (inhalation), 1984	LD <sub>50</sub> >5.18 mg/l/4h	DAS B04
Rabbit, m & f	Skin irritation	OECD guideline 404 acute dermal irritation/corrosion, 1987	No irritation	DAS B05, DAS B30
Rabbit, m & f	Eye irritation	EC method B.5 acute toxicity (eye irritation), 1992	Mild transient irritation	DAS B09, DAS B32
Guinea pig, m	Skin sensitization	OECD guideline 406 skin sensitization, 1987, Buehler test	No sensitization	DAS B28
Guinea pig, f	Skin sensitization	EC test guideline (method B.6 skin sensitisation, 1996, Magnussen & Kligman test	No sensitization	DAS B33

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\* The spinosad TC used for the toxicity studies contained 771 g/kg A and 122 g/kg D, which was considered typical for spinosad, in terms of the ratio of spinosyns A and D and the content of other compounds.

**Table B. Toxicology profile\* of spinosad technical material\*\* based on repeated administration (sub-acute to chronic)**

Species	Test	Duration and conditions	Result	References
Rabbit, m & f	21-d dermal	OECD 410	NOAEL = 1000 mg/kg bw/d	DAS D05
Rat, m & f	14-d inhalation, 15-d recovery	OECD 412	NOAEL = 9.5 mg/m <sup>3</sup>	DAS D22
Rat, m & f	13-week oral	OECD 408	NOAEL = 8.6 mg/kg bw/d LOAEL = 42.7 mg/kg bw/d	DAS D02
Rat, m & f	13-week oral	OECD 408	NOAEL = 7.7 mg/kg bw/d LOAEL = 39.1 mg/kg bw/d	DAS D20
Dog, m & f	13-week oral	OECD 409	NOAEL = 4.89 mg/kg bw/d LOAEL = 9.73 mg/kg bw/d	DAS D10
Mouse, m & f	3-month oral	OECD 408	NOAEL = 7.5 mg/kg bw/d LOAEL = 22.5 mg/kg bw/d	DAS D12
Dog, m & f	12-month oral	OECD 452	NOAEL = 2.68 mg/kg bw/d LOAEL = 8.22 mg/kg bw/d	DAS D03
Mouse, m & f	18-month oral, combined chronic toxicity and carcinogenicity	OECD 451	NOAEL = 11.4 mg/kg bw/d LOAEL = 32.7 mg/kg bw/d No carcinogenic potential	DAS I02, DAS I01, DAS I04, DAS I06
Rat, m & f	2-year oral, combined chronic toxicity and carcinogenicity	OECD 453	NOAEL = 2.4 mg/kg bw/d LOAEL = 11.4 mg/kg bw/d No carcinogenic potential	DAS I03, DAS I05
Rat	2-generation reproductive study	OECD 416	NOAEL = 10 mg/kg bw/d Reproduction NOAEL = 100 mg/kg bw/d	DAS F01
Rat	Teratogenicity	OECD 414	Maternal NOAEL = 50 mg/kg bw/d Developmental NOAEL = 200 mg/kg bw/d No teratogenic potential	DAS F03
Rabbit	Teratogenicity	OECD 414	Maternal NOAEL = 10 mg/kg bw/d Developmental NOAEL = 50 mg/kg bw/d No teratogenic potential	DAS F05
Rat, m & f	Neurotoxicity	OECD 424	No evidence of neurotoxicity in acute, sub-chronic and chronic studies	DAS B24, DAS I10, DAS D04

\* In addition to the data presented, the toxicity of a spinosyn A + D mixture was compared with that of spinosyn A (96.2%) and spinosyn D (93.0%). Spinosyn A and spinosyn D were found to display similar toxicity in mammalian systems, with spinosyn A being slightly more toxic than spinosyn D at equivalent (expressed as mg/kg bw/d) dose levels (DAS D09).

\*\* The spinosad TC used for the toxicity studies contained 771 g/kg A and 122 g/kg D, which was considered typical for spinosad, in terms of the ratio of spinosyns A and D and the content of other compounds.

In addition to the data presented in Table B, the manufacturer provided data from a 28-day oral toxicity study in rats, in which the toxicity of a spinosyn A + D mixture was compared with that of spinosyn A (96.2%) and spinosyn D (93.0%). The mixture, spinosyn A and spinosyn D were found to display similar toxicity in mammalian systems, with spinosyn A being slightly more toxic than spinosyn D at equivalent dose levels (expressed as mg/kg bw/d.)

**Table C. Mutagenicity profile of spinosad technical material\* based on *in vitro* and *in vivo* tests**

Species	Test	Conditions	Result	Reference
<i>S. typhimurium</i> TA98, TA100, TA1535, TA1537 and <i>E. coli</i> WP2uvrA	Ames test, pre-incubation <i>in vitro</i> , plate incorporation <i>in vitro</i> , OECD 471	50 to 5000 µg/plate	Negative	DAS E06
Mouse lymphoma cells, L5178Y	Mammalian cells <i>in vitro</i> , gene mutations, TK assay, OECD 476	1 to 50 µg/ml	Negative	DAS E04
Chinese hamster ovary (CHO-WB <sub>L</sub> ) cells	mammalian cells <i>in vitro</i> , cytogenic assay, OECD 473	20 to 100 µg/ml	Negative	DAS E01
Rat hepatocytes	mammalian cells <i>in vitro</i> , unscheduled DNA synthesis, OECD 482	0.1 to 5 µg/ml	Negative	DAS E02
Mouse	<i>In vitro</i> micronucleus test, OECD 474	2 daily oral doses: 500, 1000, 2000 mg/kg bw; sacrifice at 24 h after last dose	Negative	DAS E03

Based on these results, spinosad was considered to be non-genotoxic.

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\* The spinosad TC used for the toxicity studies contained 771 g/kg A and 122 g/kg D, which was considered typical for spinosad, in terms of the ratio of spinosyns A and D and the content of other compounds.

**Table D. Ecotoxicology profile\* of spinosad technical material\*\* or formulated product**

Species	Test	Duration and conditions	Result	Reference
<i>Daphnia magna</i> (water flea)	Acute toxicity, static	48 h, FIFRA 72-2 & OECD 202 Part 1 (20 ± 2°C)	EC <sub>50</sub> >1.0 mg as/l	DAS J38
<i>Daphnia magna</i> (water flea)	Acute toxicity, static, formulation 480SC	48 h, OECD 202 Part 1 (20 ± 2°C)	EC <sub>50</sub> = 9.1 mg as/l	DAS MJ06
<i>Daphnia magna</i> (water flea)	Chronic toxicity	21 d, FIFRA 72-4 & OECD 202 Part 2 (20 ± 2°C)	NOEC = 0.0012 mg as/l (flow through) NOEC = 0.0080 mg as/l (semi-static)	DAS J15
<i>Chironomus riparius</i> (midge)	Chronic toxicity, static	25 d, OECD 219 (20 ± 0.5°C)	NOEC = 0.0016 mg as/l	DAS J51
<i>Oncorhynchus mykiss</i> (rainbow trout)	Acute toxicity, static	96 h, FIFRA 72-1 & OECD 203, 12.5 ± 0.5°C	LC <sub>50</sub> = 27 mg as/l	DAS J06
<i>Lepomis macrochirus</i> (bluegill sunfish)	Acute toxicity, static	96 h, FIFRA 72-1 & OECD 203 (21-22.1°C)	LC <sub>50</sub> = 5.94 mg as/l	DAS J27
<i>Cyprinus carpio</i>	Acute toxicity, flow through	96 h, FIFRA 72-1 & OECD 203 (24.5-25.5°C)	LC <sub>50</sub> = 4 mg as/l	DAS J05
<i>Cyprinus carpio</i>	Acute toxicity, static	96 h, OECD 203 (22 ± 2°C), 480 g/l SC	LC <sub>50</sub> >49 mg as/l	DAS MJ16
<i>Oncorhynchus mykiss</i> (rainbow trout)	Early life-stage toxicity, flow through	80 day, FIFRA 72-4(a) & OECD 210 (12 ± 2°C)	NOEC = 0.5 mg as/l	DAS J12
<i>Navicula pelliculosa</i> (alga)	Static water	120 h, FIFRA 123-2 & OECD 201 (22 ± 1°C)	EC <sub>50</sub> = 0.079 mg as/l	DAS J19
<i>Navicula pelliculosa</i> (alga)	Static water, formulation 480SC	120 h, OECD 201 (22 ± 1°C)	EC <sub>50</sub> = 0.35 mg as/l	DAS MJ17
<i>Anabaena flos-aquae</i> (alga)	Static water	120 h, FIFRA 123-2 & OECD 201 (24 ± 2°C)	EC <sub>50</sub> = 6.1 mg as/l	DAS J17
<i>Selenastrum capricornutum</i> (alga)	Static water	72 h, FIFRA 123-2 & OECD 201 (24 ± 2°C)	EC <sub>50</sub> = 56 mg as/l	DAS J30
<i>Lemna gibba</i> (higher plant)	Static water	14 d, FIFRA 123-2 & OECD 221 (25.3 ± 0.15°C)	EC <sub>50</sub> = 6.6 mg/l	DAS J16

\* Data were also provided on the effects of spinosad on non-target insects, including larvae of the hoverfly *Episyrphus balteatus* (DAS MJ25), the foliar-active predator *Chrysoperla carnea* (DAS MJ24), the parasitoid wasp *Aphidius colemani* (DAS MJ22) and the carabid beetle *Poecilus cupreus* (DAS MJ23).

\*\* The spinosad TC used for the toxicity studies contained 771 g/kg A and 122 g/kg D, which was considered typical for spinosad, in terms of the ratio of spinosyns A and D and the content of other compounds.

**Table D. Ecotoxicology profile\* of spinosad technical material\*\* or formulated product**

Species	Test	Duration and conditions	Result	Reference
<i>Eisenia foetida</i> (earthworm)	Acute toxicity	14 d, 20 ± 2°C	LC <sub>50</sub> >970 mg as/kg dry soil	DAS J21
<i>Apis mellifera</i> (honey bee)	Oral exposure	OECD 213	LD <sub>50</sub> = 0.057 µg/bee (spinosad) LD <sub>50</sub> = 0.049 µg as/bee (480SC)	DAS J47
<i>Apis mellifera</i> (honey bee)	Contact exposure	OECD 214	LD <sub>50</sub> = 0.0036 µg/bee (spinosad) LD <sub>50</sub> = 0.050 µg as/bee (480SC)	DAS J20
<i>Apis mellifera</i> (honey bee)	Acute oral	EPPO 170	LD <sub>50</sub> = 0.0057 µg/bee (spinosad) LD <sub>50</sub> = 0.049 µg as/bee (480SC)	DAS MJ14
<i>Colinus virginianus</i> (bobwhite quail)	Acute oral toxicity	14 d, FIFRA 71-1	LD <sub>50</sub> >2000 mg/kg bw	DAS J24
<i>Colinus virginianus</i> (bobwhite quail)	Short-term dietary toxicity	5 d, FIFRA 71-2 & OECD 205, 88% A+D	LC <sub>50</sub> >5253 mg as/kg diet	DAS J26
<i>Colinus virginianus</i> (bobwhite quail)	Reproduction study	21 week, FIFRA 71-4(a) & OECD 206	NOEC = 550 mg/kg diet	DAS J01
<i>Anas platyrhynchos</i> (mallard duck)	Acute oral toxicity	14 d, FIFRA 71-1	LD <sub>50</sub> >2000 mg/kg bw	DAS J23
<i>Anas platyrhynchos</i> (mallard duck)	Short-term dietary toxicity	5 d, FIFRA 71-2 & OECD 205	LC <sub>50</sub> >5156 mg as/kg diet	DAS J25
<i>Anas platyrhynchos</i> (mallard duck)	Reproduction study	21 week, FIFRA 71-4(b) & OECD 206	NOEC = 550 mg/kg diet	DAS J02

The mode of action of spinosad is via activation of the nicotinic acetylcholine receptor, combined with effects on the GABA-receptor, leading to neuromuscular fatigue and paralysis in sensitive insect pests. None of the tests on mammals showed any evidence of symptoms reflecting the mode of action in target insects.

## ANNEX 2. REFERENCES

Dow AgroSciences document number	Year and title of report
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DAS A20	1993. Solubility of Compound 232105 in pH = 9 Buffer Solution for Registration.
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DAS B09	1994. XDE-105: Primary Eye Irritation Study in New Zealand White Rabbits.
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DAS B28	1996. A Skin Sensitization Study of DE-105 in Guinea Pigs (maximisation Test).
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DAS D04	1993. XDE-105: 13-Week Dietary Toxicity 4-week Recovery and 13-week Neurotoxicity Studies in Fischer 344 Rats (Neurotoxicity Portion).
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