The Director General

Maisons-Alfort, 29 November 2011

OPINION
of the French Agency for Food, Environmental and Occupational Health & Safety

on the identification of potentially usable insecticides for vector control

ANSES undertakes independent and pluralistic scientific expertise.
ANSES primarily ensures environmental, occupational and food safety as well as assessing the potential health risks they may entail.
It also contributes to the protection of the health and welfare of animals, the protection of plant health and the evaluation of the nutritional characteristics of food.

It provides the competent authorities with all necessary information concerning these risks as well as the requisite expertise and scientific and technical support for drafting legislative and statutory provisions and implementing risk management strategies (Article L.1313-1 of the French Public Health Code).

Its Opinions are made public.

On 3 June 2009, the French Ministries of Ecology, Health and Labour asked the Agency to identify potentially usable insecticides for vector control (VC).

1. BACKGROUND AND PURPOSE OF THE REQUEST

In the current context of the re-emergence of vector-borne diseases (malaria in French Guiana and Mayotte, dengue in the French overseas departments of the Americas, Réunion Island and the Pacific region, chikungunya in the Indian Ocean, and the first indigenous cases of chikungunya and dengue in mainland France), primarily due to climate change and trade globalisation, VC, and its biocide component in particular, is a critical issue. With the advent of European biocides regulations the phasing out of active substances ensures that in France control programs are primarily organised around a larvicide active substance (*Bacillus thuringiensis israelensis* [*Bti*]) and an adulticide active substance (deltamethrin)[1]. As a result, cases of resistance to deltamethrin, and to pyrethroids more generally, are now observed in various regions of France. Regarding *Bti*, recent studies describe cases of resistance to three of the four toxins in selected strains of mosquitoes in laboratories. This resistance makes the organisms that develop it less sensitive to the products and thus reduces their effectiveness as treatments. Consequently, for biocide control to have sustainable effectiveness, it must be based on the alternate use of active substances with different modes of action. Therefore, the search for new active substances that are both effective and less toxic for human health and the environment is crucial.

[1] The efficacy and risks of using *Bti* and deltamethrin in VC were assessed by AFSSET in 2007: AFSSET (2007) – *La lutte antivectorielle dans le cadre de l'épidémie de chikungunya sur l'Ile de la Réunion – Evaluation des risques et de l'efficacité des produits adulticides et larvicides* [Vector control in the context of the chikungunya outbreak on Réunion Island – Assessment of the risks and efficacy of adulticide and larvicide products].

ISSUES CONSIDERED

In order to identify insecticides that can be used for VC, the Agency was asked to conduct:

- "a review of all active substances under evaluation for product-type 18 (PT 18[2]), to select those that may have uses for the control of mosquitoes and other *Diptera*;
- monitoring in all Member States with respect to marketing authorisation (MA) for products related to PT 18 to assess the proposed uses;
- an assessment of the potential for extending to *Culicidae* insecticides evaluated or authorised within the biocides regulatory framework not targeting this family of invertebrates;
- identification of insecticides authorised as plant protection products in order to assess the possibility of extending their use to species covered by VC;
- identification of insecticides designated by various bodies (the World Health Organization [WHO], the French Institute of Research for Development [IRD], the Centre for Agricultural Research for Development [CIRAD], etc.), which could be added to the array of products used in France for the purposes of VC."

SCOPE AND LIMITATIONS OF THE FIELD OF EXPERTISE

Although VC covers a wide variety of diseases and vectors in France, at the request of the Ministries, it was agreed to limit the scope of vectors of interest to *Culicidae* and specifically *Aedes aegypti* and *Aedes albopictus*, the vectors of dengue and chikungunya, *Anopheles*, vectors of malaria, and *Culex*, vectors of the West Nile virus. In addition, the uses targeted by these expert assessments are only those related to operations conducted by VC services (treatment of larval breeding sites, indoor residual spraying with adulticides). Thus, control methods such as insecticide treated mosquito nets or repellents have not been considered in this work.

2. ORGANISATION OF THE EXPERT APPRAISAL

OVERALL ORGANISATION

The expert appraisal was carried out in accordance with French standard NF X 50-110 "Quality in Expertise – General Requirements of Competence for Expert Appraisals (May 2003)".

The Agency mandated a Working Group to analyse this request and entrusted the monitoring of the work to the Expert Committee (CES) on Assessment of the risks related to biocidal substances and products. In addition, the response to this request is also supported by the complementary skills of various Agency units.

The methodological and scientific aspects of the assessment work were regularly submitted by the Working Group to the CES. The report produced by the Working Group takes account of observations and additional information supplied by the members of the CES.

[2] Insecticides, acaricides and products to control other arthropods within the framework of the European biocides regulatory framework

APPROACH OF THIS EXPERT APPRAISAL

It was agreed to direct the process towards decision support based on the optimal use of all the information and knowledge available at the time the expert appraisal was undertaken. In this context, multicriteria methods provide a sound and structured foundation that helps those in charge to make the best choices. Accordingly, these techniques have been developed to solve problems involving quantitative, semi-quantitative and/or qualitative criteria as part of the decision-making process. Reaching an agreement among experts on the relative importance of different criteria can obviously be complex. Multicriteria analysis can help assess the relative importance of all criteria selected by the experts and reflect this in the final decision made. Multicriteria methods enable more effective integration of the opinions of experts involved in the analysis. Each expert gives an individual opinion and contributes in a distinct, identifiable way to the search for an optimal and flexible joint solution. Multicriteria methods promote dialogue among experts as well as between experts and decision makers, easily and transparently facilitating the testing of hypotheses, the addition of constraints, etc. There are many multicriteria methods offering their respective advantages and disadvantages. **The SIRIS[3] method, which is currently used to assess environmental risks and hazards, was selected for the purposes of this collective expert appraisal.**

The SIRIS method was applied to a comprehensive inventory of active insecticidal substances, with reported or assumed action on *Diptera* or mosquitoes, for some of them. This inventory was made without prejudice as to regulatory status, actual biological efficacy, toxicity or ecotoxicity, however, it was limited to active substances already on the market. The active insecticidal substances were sought among those recommended by the World Health Organization Pesticide Evaluation Scheme (WHOPES), those considered within the European biocides regulatory and plant protection framework, those used by the US Army and lastly, those used in human or veterinary antiparasitic medicinal products.

First, the best criteria for describing toxicity, ecotoxicity, exposure and the environmental fate of insecticides were chosen. These criteria were quantitative, semi-quantitative or purely qualitative. They were then ranked according to the issue being studied and the importance that the experts gave them in representing this problem area. The values of these variables were converted into two or three terms: favourable, unfavourable and potentially moderately favourable. A minimum/maximum scale of SIRIS scores was then established according to very precise incrementation rules.

It was decided to address separately an active substance's potential for use in a larvicide or an adulticide. Since the application methods were different, the challenges were likewise different in terms of toxicological and ecotoxicological risks. For each of these analyses (larvicides and adulticides), two SIRIS scores were calculated for each substance: a toxicity/ecotoxicity score and an exposure/fate score. This method led to results being expressed on a two-dimensional plane and then all active substances being compared according to their SIRIS scores, to discuss the most significant, i.e., those with the best SIRIS scores for toxicity/ecotoxicity and exposure/fate. These substances ultimately underwent a thorough **analysis of their potential** for use in VC.

KEY LIMITATIONS AND UNCERTAINTIES

The results of the SIRIS analysis should be considered as streamlined support data, intended to guide the selection by the experts of promising substances for use in VC. It is important to remember that these results are dependent on the choices that were made by the experts for the analysis and the data that were available to them at that time.

[3]System of integration of risk by integration of scores (Vaillant, M., Jouany, J.M. and Devillers, J. (1995). A multicriteria estimation of the environmental risk of chemicals with the SIRIS method. *Toxicol. Model.* 1, 57-72)

The work presented in this document is not a substitute for risk assessment carried out when applying for the inclusion of active substances in Annex 1 of Council Directive 98/8/EC[4] and for marketing authorisation. The choice ultimately belongs to the decision makers, after weighing the risks and benefits, their relationship varying depending on the context (control of vector or nuisance mosquitoes, in urban areas 'above-ground' or in the wild, during or between outbreaks, etc.).

3. ANALYSIS AND CONCLUSIONS OF THE CES

These conclusions and analysis are based on the report "*Recherche d'insecticides potentiellement utilisables en lutte antivectorielle*" [Research on potentially usable insecticides for vector control].

■ ACTIVE SUBSTANCES OF INTEREST BASED ON SIRIS ANALYSIS

Among the 129 substances (see the attached table), SIRIS analysis helped identify those with potential for use as larvicides or adulticides in VC:

- ➔ ***Bti***, currently the most commonly used substance for larvicidal treatment in France, and *Bacillus sphaericus* (***Bs)***, rank high, especially on the SIRIS scale of toxicity/ecotoxicity;
- ➔ among other strict larvicides, some **insect growth regulators**, led by **diflubenzuron** and **pyriproxyfen** (both recommended by WHOPES) show significant potential. Other insect growth regulators also of interest are **cyromazine**, **triflumuron** and **hydroprene**;
- ➔ **spinosad** and **indoxacarb** are less well positioned than the previous substances;
- ➔ **pyrethroids** also remain a group of interest for VC, although the use of **deltamethrin** could be called into question in the more or less short term due to resistance, and also because of its poor SIRIS toxicity/ecotoxicity score. Replacing this substance with Type I (**imiprothrin**, **allethrin**) or Type II (particularly **cycloprothrin**) pyrethroids or by **silafluofen**, with more advantageous SIRIS scores, is an option for keeping this group among the VC strategies. Indeed, with the exception of combinations of active substances from different chemical groups, no other chemical group currently equals the pyrethroids in terms of effectiveness against mosquitoes; therefore, they remain a gold standard;
- ➔ among **organophosphates**, **chlorpyrifos-methyl**, and possibly **temephos**, **malathion**, **formothion** or **fenthion** and **bendiocarb** (from the class of **carbamates**), have average SIRIS toxicity/ecotoxicity scores but still remain promising substances for VC since they have good SIRIS exposure/fate scores;
- ➔ **neonicotinoids** (**acetamiprid**, **imidacloprid**, **thiamethoxam**, **clothianidin**, **nitenpyram**, **thiacloprid**, **dinotefuran**) are clearly identifiable as a class of insecticides that merit consideration for vector control. This class is quite heterogeneous, especially in terms of toxicity to bees (for example, clothianidin and imidacloprid are highly toxic to bees but acetamiprid is to a lesser extent). However, neonicotinoids have relatively good SIRIS exposure/fate and toxicity/ecotoxicity scores. Moreover, they have a different mode of action from that of the insecticides currently used in VC, which is a major advantage in dealing with insecticide

[4]Annex I of Council Directive 98/8/EC known as the Biocides Directive, containing the active substances authorised for use in the EU.

resistance. Nonetheless, it is likely that these substances are insufficiently effective when used alone. Their value would be in combining them with another insecticide from a different chemical group to generate a synergistic effect;

➔ other substances, such as **spinetoram**, **chlorantraniliprole**, **ethiprole**, **dicyclanil** and **metaflumizone**, also have good SIRIS exposure/fate and toxicity/ecotoxicity scores, although this need to be confirmed by more data. Prior to use, their effectiveness against mosquitoes (larvae and/or adults), as yet unknown (only their action on *Diptera* is known), should be thoroughly tested.

The different insecticides arising out of the SIRIS analysis are potential candidates, but their risk assessment is required before they can be deployed.

It should be noted that the current term of the biocides regulatory framework, and thus of insecticides for VC, is transitional since not all products on the market have yet been evaluated. In the end, any use of an insecticide for VC will be subject to marketing authorisation. This authorisation will be issued on the basis of a full assessment of its efficacy and risks according to Council Directive 98/8/EC on biocidal products.

- **STRATEGIES FOR THE USE OF INSECTICIDES IN VC**

➔ VC must be **integrated** and **sustainable**, based on surveillance of vectors and pathogens, and on striving to minimise adverse effects as much as possible. The sustainability of effectiveness of the active substances calls for a **strategy for preventing the vectors from developing resistance** by alternating the active substances used. When resistance to an active substance is observable in a vector in the field, it has already reached an irreversible level that will quickly render the substance operationally ineffective. Knowledge of resistance levels is basic information to be acquired for all vector/insecticide class pairings, and in all territories. Furthermore, the course of resistance must be monitored.

➔ For *Aedes* and *Culex*, VC should first be **larvicidal** and **preventive**. Breeding sites must be treated continuously, including in periods between outbreaks, in order to keep vector populations at the lowest levels. Adulticide treatments are appropriate in the event of outbreaks.

➔ For control of *Anopheles* vectors of malaria, adulticides (treated mosquito nets, indoor residual spraying) should be put into operation first.

➔ It should also be recalled that VC does not entail biocides alone and that it should be **integrated**, which means that it should be combined with all other methods, in a complementary manner. Health education through information campaigns, and raising public awareness about the importance of eliminating larval breeding sites have already proved their value and should be extended and continued. The use of biocides is inevitably associated with a varying degree of risk, depending on the products and their applications; thus, methods other than VC should be encouraged to the extent possible.

- **OUTLOOK**

This expert appraisal dealt with VC treatments performed by public operators to combat *Anopheles*, *Aedes* and *Culex*. The approach that was followed could be applied to other uses of VC (for example, treated mosquito nets, indoor residual spraying) and other lesser vectors, using other scenarios for the SIRIS analysis.

While it was not covered in this assessment work, the insecticide-treated mosquito net is an especially important tool for controlling malaria. They are basically personal protective tools, but they can be considered as collective protective tool when their distribution and

recovery are planned and organised by VC services. However, they are less suited for protection against *Aedes,* which is diurnally active.

In the short term, this expert appraisal aims to shed light on potential alternatives to substances currently used for VC, by investigating those that are already on the market. In the long term, the search for new classes of high-performing insecticides for action on different targets should be encouraged.

Combining active substances (insecticide/insecticide and insecticide/repellent) with different modes of action, resulting in synergy, is a promising avenue and still under-utilised in VC compared to control of crop pests. The desired objective is to increase treatment effectiveness while reducing the doses of the active substances used. Thus, research work on neonicotinoid + oxadiazine and neonicotinoid + phenylpyrazole is underway. It now remains to be confirmed whether such combinations can produce a synergistic effect both at the operational level in the field, and in the laboratory. Consideration should be given to the feasibility of integrating neonicotinoids in VC strategies.

Active substances are formulated into products, which can significantly alter the intrinsic properties of the active substances themselves. By modifying the formulation of an existing product, it is possible to optimise the potential of an active substance for use in VC. In addition, research on innovative new formulations that may contribute to safer use of active substances in VC, should be intensified.

The data obtained by environmental impact surveillance and toxicant monitoring provide feedback and help to adjust treatment programs.

4. THE AGENCY'S CONCLUSIONS AND RECOMMENDATIONS

The French Agency for Food, Environmental and Occupational Health & Safety endorses the conclusions and recommendations of the CES.

These conclusions and recommendations were valid at the time that the expert appraisal was conducted since the results of the SIRIS analysis were dependent on the data that were available and the choices that were made by the experts for the analysis. Any new data (scientific, technical, etc.) could thus lead to these conclusions being amended. Therefore, the Agency will monitor these insecticides, in complement to monitoring conducted by the National Centre for Vector Expertise (CNEV) on vectors and that of the French Institute for Public Health Surveillance (InVS) on vector-borne disease outbreaks in the various regions of France.

In addition, several items relating to the work conducted and its conclusions should be put in perspective.

- Based on a review of 129 insecticide substances that are effective, or assumed to be effective on *Diptera*, the Agency's pioneering work has helped to identify 32 adulticide and/or larvicide substances used or potentially usable for VC. This selection of 32 candidate substances resulted from – as separate from a ranking approach – a consensus among a multidisciplinary group of experts (in entomology, toxicology, ecotoxicology, etc.).
- The selection of the 32 substances primarily takes into account acute toxicity/ecotoxicity effects, as those are the most documented. Chronic effects need to be characterised in greater detail, substance by substance, because this is less well documented. It is necessary to assess the risks and efficacy connected with the use of an insecticide, in all cases, considering the various routes of exposure and specific populations, should it be necessary to integrate this in the implementation of a specific VC strategy. It should take into account the history of

previous applications of the insecticides used for VC and their health and environmental impact.

- This work cannot in any way be interpreted as a favourable Opinion of the Agency on the use of these 32 substances in the context of VC. Moreover, the Agency should continue its expert assessments of these 32 candidate substances in order to specify each one's toxicity and ecotoxicity profile. This work will refine the list of candidate substances, as necessary.
- Among the various chronic toxicity/ecotoxicity effects to be taken into account, the endocrine disrupting effects of the candidate substances must be mentioned because there is little or no current documentation on them. This is now a priority issue for deltamethrin, given its current preferential use in France as a VC adulticide.
- The Agency proposes considering without delay, in conjunction with the Ministries responsible for VC, the possibility of initiating work to assess the efficacy of the candidate substances that have a favourable toxicity/ecotoxicity profile but which are currently poorly documented in terms of effectiveness against mosquitoes (spinetoram, chlorantraniliprole, ethiprole, dicyclanil and metaflumizone). In the same context, additional work on combining active substances should be promoted.
- The use of these substances in VC naturally raises the risk-benefit issue, in the light of health and environmental concerns. This assessment must be carried out on a case-by-case basis. Nevertheless, the limited availability of operational tools for this assessment should be emphasised. These deficiencies justify conducting *ad hoc* methodological work.
- It should be remembered that the work did not focus on the identification of candidate substances for such uses as treated mosquito nets and indoor residual spraying, or in VC intended to combat zoonoses and animal diseases. Substances for these uses could be prioritised taking the same approach, but this requires a review of the ranking criteria.

Finally, the Agency wishes to draw attention to the limited economic interest in the VC market by pesticides manufacturers: this interest is opposed to the need for a wide range of substances. It is therefore necessary to create incentives that persuade manufacturers to develop products for VC and support the submission of registration applications for active substances and products. Collaboration between the government, industry and research, along the lines of WHOPES or the Global Alliance for Alternatives to DDT, is a model to consider.

The Director General

Marc MORTUREUX

KEY WORDS

Vector control, insect control, disease vector, insect vector, insecticide, biocide, ranking, multicriteria method, SIRIS.

ANNEX

Table: List of 129 active substances that are effective or potentially effective against mosquitoes

Active substance	CAS RN	Chemical group
Allethrin	584-79-2	Pyrethroids
d-Allethrin	-	Pyrethroids
Bioallethrin (= d-trans-Allethrin)	260359-57-7	Pyrethroids
Esdepallethrin (= S-bioallethrin)	28434-00-6	Pyrethroids
Esbiothrin	260359-57-5	Pyrethroids
Bifenthrin	82657-04-3	Pyrethroids
Cycloprothrin	63935-38-6	Pyrethroids
Cyhalothrin	68085-85-8	Pyrethroids
Gamma-cyhalothrin	76703-62-3	Pyrethroids
Lambda-cyhalothrin	91465-08-6	Pyrethroids
Cyfluthrin	68359-37-5	Pyrethroids
Beta-cyfluthrin	68359-37-5	Pyrethroids
Cypermethrin	52315-07-8	Pyrethroids
Alpha-cypermethrin	67375-30-8	Pyrethroids
Beta-cypermethrin	65731-84-2	Pyrethroids
Zeta-cypermethrin	52315-07-8	Pyrethroids
Cyphenothrin	39515-40-7	Pyrethroids
d,d-trans-cyphenothrin	-	Pyrethroids
Deltamethrin	52918-63-5	Pyrethroids
Empenthrin	54406-48-3	Pyrethroids
Esfenvalerate	66230-04-4	Pyrethroids
Etofenprox	80844-07-1	Pyrethroids
Fenpropathrin	39515-41-8 / 64257-84-7	Pyrethroids
Fenvalerate	51630-58-1	Pyrethroids
Flucythrinate	70124-77-5	Pyrethroids
Imiprothrin	72963-72-5	Pyrethroids
Kadethrin	58769-20-3	Pyrethroids
Metofluthrin	240494-70-6	Pyrethroids
Permethrin	52645-53-1	Pyrethroids
Phenothrin	26002-80-2	Pyrethroids
d-Phenothrin (Sumithrin)	73170-79-3	Pyrethroids
Prallethrin	23031-36-9	Pyrethroids
Resmethrin	10453-86-8	Pyrethroids
Bioresmethrin	28434-01-7	Pyrethroids

Active substance	CAS RN	Chemical group
Silafluofen	105024-66-6	Pyrethroids
Tau-fluvalinate	102851-06-9	Pyrethroids
Tefluthrin	79538-32-2	Pyrethroids
Tetramethrin	7696-12-0	Pyrethroids
d-Tetramethrin	1166-46-7	Pyrethroids
Tralomethrin	66841-25-6	Pyrethroids
Transfluthrin	118712-89-3	Pyrethroids
Pyrethrin	8003-34-7	Pyrethrins
Azamethiphos	35575-96-3	Organophosphates
Azinphos-methyl	86-50-0	Organophosphates
Bromophos-ethyl	4824-78-6	Organophosphates
Chlorfenvinphos	470-90-6	Organophosphates
Chlorpyrifos	2921-88-2	Organophosphates
Chlorpyrifos-methyl	5598-13-0	Organophosphates
Coumaphos	56-72-4	Organophosphates
Cyanophos	2636-26-2	Organophosphates
Diazinon	333-41-5	Organophosphates
Dichlofenthion	97-17-6	Organophosphates
Dichlorvos	62-73-7	Organophosphates
Dimethoate	60-51-5	Organophosphates
Ethion (= diethion)	563-12-2	Organophosphates
Ethoprophos	13194-48-4	Organophosphates
Fenchlorphos	299-84-3	Organophosphates
Fenitrothion	122-14-5	Organophosphates
Fenthion	55-38-9	Organophosphates
Fonofos	944-22-9	Organophosphates
Formothion	2540-82-1	Organophosphates
Heptenophos	23560-59-0	Organophosphates
Iodofenphos	18181-70-9	Organophosphates
Malathion	121-75-5	Organophosphates
Mecarbam	2595-54-2	Organophosphates
Naled	300-76-5	Organophosphates
Omethoate	1113-02-6	Organophosphates
Phenthoate	2597-03-7	Organophosphates
Phorate	298-02-2	Organophosphates
Phosmet	732-11-6	Organophosphates
Phosphamidon	13171-21-6	Organophosphates
Phoxim	14816-18-3	Organophosphates

Active substance	CAS RN	Chemical group
Pirimiphos-ethyl	23505-41-1	Organophosphates
Pirimiphos-methyl	29232-93-7	Organophosphates
Propetamphos	31218-83-4	Organophosphates
Pyraclofos	77458-01-6	Organophosphates
Pyridaphenthion	119-12-0	Organophosphates
Quinalphos	13593-03-8	Organophosphates
Sulfotep	3689-24-5	Organophosphates
Tebupirimfos	96182-53-5	Organophosphates
Terbufos	13071-79-9	Organophosphates
Temephos	3383-96-8	Organophosphates
Trichlorfon	52-68-6	Organophosphates
Aldicarb	116-06-3	Carbamates
Bendiocarb	22781-23-3	Carbamates
Benfuracarb	82560-54-1	Carbamates
Carbofuran	1563-66-2	Carbamates
Carbosulfan	55285-14-8	Carbamates
Formetanate	22259-30-9	Carbamates
Methiocarb (= mercaptodimethur)	2032-65-7	Carbamates
Methomyl	16752-77-5	Carbamates
Propoxur	114-26-1	Carbamates
Chlordane	57-74-9	Organochlorines
DDT	50-29-3	Organochlorines
Endosulfan	115-29-7	Organochlorines
Lindane	58-89-9	Organochlorines
Methoxychlor	72-43-5	Organochlorines
Acetamiprid	135410-20-7	Neonicotinoids
Clothianidin	210880-92-5	Neonicotinoids
Dinotefuran	165252-70-0	Neonicotinoids
Imidacloprid	138261-41-3	Neonicotinoids
Nitenpyram	150824-47-8	Neonicotinoids
Thiacloprid	443096-59-1	Neonicotinoids
Thiamethoxam	153719-23-4	Neonicotinoids
Chlorantraniliprole	500008-45-7	Anthranilamides
Chlorfenapyr	122453-73-0	Arylpyrroles
Abamectin	71751-41-2	Avermectins
Indoxacarb	173584-44-6	Oxadiazines
Ethiprole	181587-01-9	Phenylpyrazole
Fipronil	120068-37-3	Phenylpyrazole

Active substance	CAS RN	Chemical group
Spinetoram	187166-40-1 / 187166-15-0	Spinosyns
Spinosad	131929-60-7	Spinosyns
Metaflumizone	139968-49-3	Others
Piperonyl butoxide (PBO)	51-03-6	Others
Diflubenzuron	35367-38-5	Benzoyl ureas
Hexaflumuron	86479-06-3	Benzoyl ureas
Novaluron	116714-46-6	Benzoyl ureas
Teflubenzuron	83121-18-0	Benzoyl ureas
Triflumuron	64628-44-0	Benzoyl ureas
Azadirachtin	11141-17-6	Insect growth regulators
Cyromazine	66215-27-8	Insect growth regulators
Dicyclanil	112636-83-6	Insect growth regulators
Fenoxycarb	79127-80-3	Insect growth regulators
Hydroprene	41205-09-8 / 41096-46-2	Juvenile hormone mimetics
Methoprene	40596-69-8	Juvenile hormone mimetics
S-methoprene	65733-16-6	Juvenile hormone mimetics
Pyriproxyfen	95737-68-1	Juvenile hormone mimetics
Bs	-	Microorganism
Bti	-	Microorganism