A study on the use of and alternatives for five insecticides (PT18)

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Author(s)
dr. Kees Le Blansch; Bureau KLB
Renate Groot, MSc; Antea Group
Gerhard Geurtse BSc; Kennis- en Adviescentrum Dierplagen (KAD)
Aron Kuiper, MSc; Kennis- en Adviescentrum Dierplagen (KAD)

Client
Ministerie van Infrastructuur en Waterstaat
Postbus 20906
2500 EX Den Haag

Controlled
Amanda Jacobs-Jansen, MSc

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Summary

- *Report and summary*

This report describes the results of a study of the current use, hazards, and risks, as well as the potential for replacement of insecticides (PT18) based on the active substances cypermethrin, alpha-cypermethrin, deltamethrin, imidacloprid, and lambda-cyhalothrin. This research was conducted on behalf of the Ministry of Infrastructure and Water Management, Directorate General for the Environment and International affairs (IandW DGMI), which wants to use the study's results both for its input into EU decision-making on the reassessment of the approval of these substances and for considering measures to effectively reduce the current limit-exceeding concentrations of these substances in Dutch surface waters.
This summary briefly outlines the results of the research.

- *Research method*

The research was conducted through desk research (document study and study of databases with approval and authorisation data, as well as emission and water pollution data), interviews with those involved in and around the chain of production and use of the insecticides and a survey among EU Member States where traded volumes of biocides are registered. In total, exchanges took place with 46 parties (written response or interview). In addition, 5 Dutch government parties were consulted about the sources and search directions involved.
Based on all this, the research has led to conclusions on the key questions, which are summarized below.

- *Authorisations*

The first main question is: Which insecticides based on these active substances are currently authorised and for which specific applications?

The conclusions are:
- Insecticides based on these active substances are approved for both professional and non-professional use.
- Depending on the target organism, products may be approved for indoor use only or also for outdoor use.

The table below provides a summarising overview of the authorised products.

Active substance	N products	Authorised for:
Cypermethrin	1 product	Indoor curative treatment in cracks and crevices against German cockroach, oriental cockroach, black garden ant, and other crawling insects; indoor curative treatment in wasp nests; outdoor curative treatment in ant nests
Alpha-cypermethrin	2 products	Only for indoor use in animal housing: curative treatment on surfaces and in cracks and crevices against German cockroach, black garden ant, housefly, stable fly, mosquitoes, and wasps
Deltamethrin	18 products	Indoor curative treatment on surfaces and in cracks and crevices against ants, mosquitoes, woodlice, cockroaches, wasps, flies, bed bugs, spiders, silverfishes, and other crawling insects; indoor curative treatment in wasp nests; outdoor curative treatment in ant nests
Imidacloprid	11 products	Indoor curative treatment as baiting formula against ants, flies, and cockroaches; outdoor curative treatment in ant nests
Lambda-cyhalothrin	2 products	Indoor curative treatment against ants and flies; outdoor curative treatment in ant nests

- *Use*

The second main question is: what is known about the current use of these insecticides, both qualitatively (nature of application, field of application, function) and quantitatively (volumes)?

The conclusions in qualitative terms are as follow:
- The insecticides in question are widely used for the control of small pests by consumers, non-professionals as well as by professionals (qualified Pest Control Officers (PCOs) and agricultural use).
- Indoor use takes place in private homes and in buildings in all possible sectors, as well as in animal housing. Outdoor use takes place in ant and wasp nests, as well as around private homes and other buildings.
- Next to insecticides, there are several other uses of these active substances, see table below.

	Biocide (PT18)		Biocide (PT8)	Plant Protection Product (PPP)	Veterinary medicine
	Products	Treated articles	Treated articles		
Cypermethrin	Yes	Yes	Yes	Yes	Yes
Alpha-cypermethrin	Yes	-	-	-	-
Deltamethrin	Yes	-	-	Yes	Yes
Imidacloprid	Yes	-	-	-	Yes
Lambda-cyhalothrin	Yes	-	-	Yes (but is being removed from the market)	-

The conclusions in quantitative terms are:
- Since Dutch data on the volume of traded insecticides are lacking and data from other countries that have shared information are difficult to interpret (for instance due to high variability between and within data sets), no quantitative conclusions can be drawn based on these data.

- *Risks*

The next main question is: what is known about the dangers and risks of using these products?

The conclusions are:
- There are several hazards from these products for human health (toxicity (all five), skin irritation (cypermethrin and deltamethrin) and perhaps endocrine disruption (cypermethrin and imidacloprid).
- The main concern is, however, in their hazardous properties for the environment:
  - They are all very toxic to aquatic life, both acute and chronic.
  - Lambda-cyhalothrin and its metabolite TFA are PFASs, a.k.a. 'forever chemicals' due to their persistence.
  - All substances act not only on the unwanted pests but also affect insects that are perceived as beneficial such as bees (non-target species). They lead to disturbances in the soil ecosystem, food webs and biodegradation cycles, also resulting in less food for amphibians, reptiles, and birds.
  - Against all 5 substances resistance has been found among specific target organisms (mostly outside of the Netherlands).
- Different (levels of) risks are associated with different user groups.
  - PCOs are highly trained and largely work in accordance with use instructions (SPCs). Under these circumstances the risks for humans and the environment are reasonably controlled (although this use can still lead to limit-exceeding water pollution).
  - Agricultural use brings along higher risks, firstly because agrarians do not require training to be allowed to use these insecticides on their own farm, and secondly because this use takes place in rural areas, close to nature and surface waters, and in animal farms where insecticides can spread via manure.
  - The risks of consumer use are considered to be relatively highest. Consumers are seen to be largely unaware of the risks, to not always read and follow instructions and to tend to use too high doses to achieve effective pest control (even though they generally use 'foolproof' products with low concentrations for indoor use). There are indications that consumers themselves run more than negligible risks from these products.

- *Alternatives*

From a preventative (integrated pest management) perspective, the main questions are: what is the risk awareness of the various actors dealing with insecticides based on these 5 active substances, what are the current possibilities for alternative insect control and for substituting these substances, and what drives and hinders substitution?

The conclusions are:
- Risk awareness is said to be high among professional pest controllers and lowest among private users (although increasing); agricultural users are somewhere in between.
- There are several non-chemical alternatives for the control of insect infestations, which can be divided into preventive, mechanical, biological and physical control techniques. However, in case of large infestations these might not be sufficient, and a professional pest control treatment – with the use of (these)

insecticides – is still deemed necessary. Additionally, not all treatments can be applied in all situations, which is true for both chemical and non-chemical methods.

- All professional interviewees indicate that they take integrated pest management (IPM) as a starting point for controlling insect populations. This is supported by wholesalers who see more use of non-chemical methods.
- For consumers many alternatives are available, particularly for dealing with local and small infestations. Some interviewees state that consumers are slowly shifting towards these alternatives; others see no change in this regard. Several interviewees point at the current availability of chemical insecticides that draws consumers (too easily) towards these options.
- Niche solutions are sometimes available for professionals, like heat or low oxygen treatment and displacement of wasp-nests. They are however not applicable in every pest situation.
- There are barriers for clients (consumers, institutions and companies) to call in the help of PCOs. Often clients expect a quick and easy solution, i.e. insecticide treatment, while PCOs often employ a broader, IPM-oriented approach. These methods may be more expensive and not as quick as a client might want.
- Innovation toward alternative active substances is slow or even at a standstill, due to failing business-cases vis-à-vis small margins and turnovers in biocide markets.

- *Contribution to water pollution*

The main question in relation to the surface water quality problem of these substances is: to what extent do historical, current and future use of these PT18 insecticides and treated articles contribute to the problems with surface water pollution? (Also in relation to the use of the 5 active substances in other types of products?).

Conclusions are:

- Particularly for deltamethrin and lambda-cyhalothrin, all measurements indicate that the largest part of the limit exceedances in surface water with the active substances concerned, originates from plant protection products (PPP). In addition, and particularly for imidacloprid, veterinary medicines are a significant potential source. The prevailing opinion is that the share of biocides, based on the 5 active substances included in this study, is small – although not necessarily negligible.
- There is a lack of insight into the origin of active substances where there presence in surface water is detected. Several interviewees call for more research in this respect.
- Potential emission of insecticides (as PT18 biocide) to surface water occurs mainly by run-off or by washing out (via the sewer, via spread from manure, via soil or directly). Additionally, illegal use can lead to emissions, for instance from the use of leftover supplies of banned products, from using excessive doses, from use in non-authorised locations, from (early) wet-cleaning or from discharging excess spray liquid or rinse water into the sewer.

- *What if approval is granted or withheld?*

The final question is: what will be the impact of renewed approval, restrictions or a decision to completely ban (in the EU and/or in the Netherlands) the use of these active substances for PT18 insecticides?

The conclusions are:

- *<u>In case of no additional restrictions:</u>* If approval is renewed and no additional restrictions are introduced, these products will be sold and used as they currently are. A continuation of the current situation – also including a continuation of the use of these substances in PPP and veterinary medicine – will not reduce water pollution with these active substances, and might even increase this, due to build-up of persistent chemicals. The same holds true for pollution with PFAS. A reliance on the same active substances will most likely, in the long run, lead to resistant pest species.
- *<u>In case of a complete ban:</u>* A complete ban of these insecticides may lead to a certain reduction of risks for humans and for the environment (including risks to non-target species and water pollution), although the continuing use of PPPs and veterinary medicine with these active substances will still have their (probably stronger) effect. Lambda-cyhalothrin (a PFAS-chemical) can be substituted by another synthetic pyrethroid. At the same time, effects will include: a reduced toolbox for PCOs, which might result in the inability to manage certain pests, leading to subsequent risks e.g. spread of disease-carrying insects in the future, as well as an increased dependency on fewer available options, increasing the chance of resistance build-up. Also, the margins for producers are reduced, resulting in less funds for innovation in (low risk) chemical

insecticides. However, a growing demand for non-chemical alternatives could also stimulate innovation in this field.

- *In case of selective restrictions*: if a continuation of the current situation is unwanted and if a complete ban of these insecticides has too many side-effects, certain restrictions can be considered, like:
  - Restrict the use of these active substances in PPP and veterinary medicine, as indications are that the risks of using these products outweigh the risks of using PT18 insecticides.
  - Examine if active substances that are PFAS or that have PFAS as metabolite, can be restricted under the BPR.
  - Ban these products for consumer use. Consumers have plenty alternatives to deal with nuisances and small infestations. In case of more serious infestations they can hire PCOs. However, the costs of hiring a PCO may prevent consumers from doing so (allowing the infestation to worsen). A ban also may give rise to illegal import of non-authorized insecticides and to the use of home remedies (vinegar, bleach).
  - Create a certain barrier for sale of these products to consumers by only allowing sales over the counter or on prescription. This could also add to the awareness of the risks of these products.
  - Introduce a certification requirement for agricultural users of insecticides, only to be attained after proof of professional competence (training and examination), as a condition for the use of insecticides as biocides.
  - Introduce a legal requirement for professional users of insecticides to apply the IPM method, including guidelines for their use.
  - Raise awareness by means of targeted communication, both to professional users (including agrarians) and to consumers.
  - Stimulate the use of non-chemical methods, of preventive measures and of control methods with low risk (next to restrictions of the use of chemical products). This could further enlarge the availability of alternatives and reduce the impulse to use insecticides for all user groups.
  - Carry out more measurements to trace sources of water contamination (possibly by use of markers).

Samenvatting

- *Rapport en samenvatting*

Dit rapport beschrijft de resultaten van een onderzoek naar het huidige gebruik, de gevaren en risico's en naar het vervangingsperspectief van insecticiden (PT18) op basis van de werkzame stoffen cypermethrin, alfa-cypermethrin, deltamethrin, imidacloprid en lambda-cyhalothrin. Het onderzoek is uitgevoerd in opdracht van het Ministerie van Infrastructuur en Waterstaat, Directoraat-generaal Milieu en Internationaal (IenW DGMI), dat de resultaten van het onderzoek, zowel wil gebruiken voor zijn inbreng in de EU-besluitvorming over de herbeoordeling van de toelating van deze stoffen, als voor het overwegen van maatregelen om de huidige grenswaardeoverschrijdende concentraties van deze stoffen in het Nederlandse oppervlaktewater effectief te verlagen.
In deze samenvatting worden de resultaten van het onderzoek kort weergegeven.

- *Onderzoeksmethode*

Het onderzoek is uitgevoerd door middel van deskresearch (documentstudie en bestudering van databases met toelatings- en toelatingsgegevens en met emissie- en waterverontreinigingsgegevens), interviews met betrokkenen in en rond de keten van productie en gebruik van de insecticiden, en een uitvraag onder EU-lidstaten waar verhandelde hoeveelheden biociden worden geregistreerd. In totaal vonden uitwisselingen plaats met 46 partijen (zowel per interview als schriftelijk). Daarnaast zijn 5 Nederlandse overheidspartijen geraadpleegd over de te betrekken bronnen en te hanteren zoekrichtingen.
Op basis van dit alles heeft het onderzoek geleid tot conclusies over de belangrijkste vragen, die hieronder zijn samengevat.

- *Toelatingen*

De eerste hoofdvraag is: welke insecticiden op basis van deze werkzame stoffen zijn momenteel toegelaten en voor welke specifieke toepassingen?

De conclusies zijn:
- Insecticiden op basis van deze werkzame stoffen zijn goedgekeurd voor zowel professioneel als niet-professioneel gebruik.
- Afhankelijk van het doelorganisme kunnen producten alleen worden goedgekeurd voor gebruik binnenshuis of ook voor gebruik buitenshuis.

De onderstaande tabel geeft een samenvattend overzicht van de toegelaten producten.

Actieve stof	N producten	Toegestaan gebruik voor:
Cypermethrin	1 product	Curatieve behandeling binnenshuis in spleten en kieren tegen Duitse kakkerlak, oosterse kakkerlak, zwarte tuinmier en andere kruipende insecten; curatieve behandeling binnenshuis in wespennesten; curatieve behandeling buitenshuis in mierennesten
Alpha-cypermethrin	2 producten	Alleen voor gebruik binnenshuis in dierenverblijven: curatieve behandeling op oppervlakken en in spleten en kieren tegen Duitse kakkerlak, zwarte tuinmier, huisvlieg, stalvlieg, muggen en wespen.
Deltamethrin	18 producten	Curatieve behandeling binnenshuis op oppervlakken en in spleten en kieren tegen mieren, muggen, pissebedden, kakkerlakken, wespen, vliegen, bedwantsen, spinnen, zilvervisjes en andere kruipende insecten; curatieve behandeling binnenshuis in wespennesten; curatieve behandeling buitenshuis in mierennesten.
Imidacloprid	11 producten	Curatieve behandeling binnenshuis als lokaas tegen mieren, vliegen en kakkerlakken; curatieve behandeling buitenshuis in mierennesten
Lambda-cyhalothrin	2 producten	Curatieve behandeling binnenshuis tegen mieren en vliegen; curatieve behandeling buitenshuis in mierennesten

- *Gebruik*

De tweede hoofdvraag is: wat is er bekend over het huidige gebruik van deze insecticiden, zowel kwalitatief (aard van de toepassing, toepassingsgebied, functie) als kwantitatief (hoeveelheden)?

De kwalitatieve conclusies zijn:
- De insecticiden in kwestie worden op grote schaal gebruikt voor de bestrijding van kleine plagen door consumenten, niet-professionals en ook door professionals (gekwalificeerde plaagdierbeheersers en gebruik in de landbouw).
- Het gebruik binnenshuis vindt plaats in particuliere woningen en in gebouwen in alle mogelijke sectoren, evenals in dierenverblijven. Buitengebruik vindt plaats in mieren- en wespennesten en rond particuliere woningen en andere gebouwen.
- Naast insecticiden zijn er verschillende andere toepassingen van deze werkzame stoffen, zie onderstaande tabel.

	Biocide (PT18)		Biocide (PT8)	Gewasbeschermings-middel	Diergeneesmiddel
	Product	Behandeld voorwerp	Behandeld voorwerp		
Cypermethrin	Ja	Ja	Ja	Ja	Ja
Alpha-Cypermethrin	Ja	-	-	-	-
Deltamethrin	Ja	-	-	Ja	Ja
Imidacloprid	Ja	-	-	-	Ja
Lambda-cyhalothrin	Ja	-	-	Ja (maar wordt van de markt verwijderd)	-

De kwantitatieve conclusies zijn:
- Omdat Nederlandse gegevens over de hoeveelheid verhandelde insecticiden ontbreken en gegevens van andere landen die wel informatie hebben gedeeld, moeilijk te interpreteren zijn (bijvoorbeeld door grote variabiliteit tussen en binnen datasets), kunnen op basis van deze gegevens geen kwantitatieve conclusies worden getrokken.

- *Risico's*

De volgende hoofdvraag is: wat is er bekend over de gevaren en risico's van het gebruik van deze producten?

De conclusies zijn:
- Er zijn verschillende gevaren van deze producten voor de menselijke gezondheid toxiciteit (alle vijf), huidirritatie (cypermethrin en deltamethrin) en mogelijk hormoonverstoring (cypermethrin en imidacloprid).
- De grootste zorg zit echter in hun gevaarlijke eigenschappen voor het milieu:
  - Ze zijn allemaal zeer toxisch voor waterleven, zowel acuut als chronisch.
  - Lambda-cyhalothrin en zijn metaboliet TFA zijn PFAS'en, ook wel ‘forever chemicals’ genoemd vanwege hun persistentie.
  - Alle stoffen werken niet alleen in op de ongewenste plagen, maar tasten ook insecten aan die als nuttig worden beschouwd, zoals bijen (niet-doelsoorten). Ze leiden tot verstoringen in het bodemecosysteem, voedselketens en biologische afbraakcycli, wat ook resulteert in minder voedsel voor amfibieën, reptielen en vogels.
  - Tegen alle 5 stoffen is resistentie gevonden bij specifieke doelorganismen (meestal buiten Nederland).
- Verschillende (niveaus van) risico's zijn geassocieerd met verschillende gebruikersgroepen.
  - Professionele plaagdierbeheersers zijn hoog opgeleid en werken grotendeels volgens gebruiksinstructies. Onder deze omstandigheden zijn de risico's voor mens en milieu redelijk onder controle (hoewel dit gebruik nog steeds kan leiden tot grenswaardeoverschrijdende waterverontreiniging).
  - Agrarisch gebruik brengt hogere risico's met zich mee, ten eerste omdat agrariërs geen training nodig hebben om deze insecticiden op hun eigen erf te mogen gebruiken. Ten tweede omdat dit gebruik plaatsvindt in landelijke gebieden, dicht bij natuur en oppervlaktewater, en in veehouderijen waar insecticiden zich via mest kunnen verspreiden.
  - De risico's van consumentengebruik worden relatief het grootst geacht. Het beeld is dat consumenten zich grotendeels niet bewust zijn van de risico's, niet altijd de gebruiksaanwijzing lezen en volgen en de neiging hebben om te hoge doseringen te gebruiken voor een effectieve bestrijding van ongedierte (ook al gebruiken ze over het algemeen ‘foolproof’ producten met lage concentraties voor gebruik

binnenshuis). Er zijn aanwijzingen dat consumenten zelf meer dan verwaarloosbare risico's lopen door deze producten.

- *Alternatieven*

Vanuit een preventief perspectief (geïntegreerde plaagdierbestrijding) zijn de belangrijkste vragen: wat is het risicobewustzijn van de verschillende actoren die te maken hebben met insecticiden op basis van deze vijf werkzame stoffen, wat zijn de huidige mogelijkheden voor alternatieve insectenbestrijding en voor vervanging van deze stoffen, en wat stimuleert en belemmert vervanging?

De conclusies zijn:

- Het beeld is dat het risicobewustzijn onder professionele plaagdierbeheersers hoog is, en onder particuliere gebruikers het laagst (hoewel dit toeneemt); agrarische gebruikers zitten daar ergens tussenin.
- Er zijn verschillende niet-chemische alternatieven voor de bestrijding van insectenplagen, die kunnen worden onderverdeeld in preventieve, mechanische, biologische en fysische bestrijdingstechnieken. In het geval van grote plagen kunnen deze echter ontoereikend zijn en wordt de inzet van professionele plaagdierbeheersing – met gebruik van (deze) insecticiden – noodzakelijk geacht. Bovendien kunnen niet alle behandelingen in alle situaties worden toegepast, wat geldt voor zowel chemische als niet-chemische methoden.
- Alle professionele geïnterviewden geven aan dat ze geïntegreerde plaagbestrijding (IPM) als uitgangspunt nemen voor het bestrijden van insectenpopulaties. Dit wordt ondersteund door groothandelaren die zien dat meer gebruik wordt gemaakt van niet-chemische methoden.
- Voor consumenten zijn er veel alternatieven beschikbaar, vooral voor lokale en kleine plagen. Sommige ondervraagden geven aan dat consumenten langzaam opschuiven naar het gebruik van deze alternatieven; anderen zien geen verandering in dit opzicht. Verschillende geïnterviewden wijzen erop dat de huidige beschikbaarheid van chemische insecticiden consumenten (te gemakkelijk) naar deze opties trekt.
- Niche-oplossingen zijn soms beschikbaar voor professionals, zoals behandeling met hitte of lage zuurstofconcentraties en het verplaatsen van wespennesten. Deze zijn echter niet toepasbaar bij elke plaag.
- Er zijn barrières voor klanten (consumenten, instellingen en bedrijven) om de hulp van professionele plaagdierbeheersers in te roepen. Vaak verwachten klanten een snelle en gemakkelijke oplossing, d.w.z. een behandeling met insecticiden, terwijl de ingehuurde professionals vaak een bredere, IPM-georiënteerde aanpak hanteren. Deze methoden kunnen duurder zijn en niet zo snel werken als een klant zou willen.
- Innovatie in de richting van alternatieve werkzame stoffen verloopt traag of staat zelfs stil, als gevolg van tekortschietende verdienmodellen, mede in relatie tot de kleine marges en omzetten in biocidenmarkten.

- *Bijdrage aan watervervuiling*

De belangrijkste vraag met betrekking tot het probleem van oppervlaktewaterkwaliteit: in welke mate draagt het historische, huidige en toekomstige gebruik van deze PT18 insecticiden en behandelde artikelen bij aan de problemen met oppervlaktewatervervuiling? (Ook in relatie tot het gebruik van de 5 werkzame stoffen in andere soorten producten?).

Conclusies zijn:

- Met name voor deltamethrin en lambda-cyhalothrin blijkt uit alle metingen dat het grootste deel van de grenswaardeoverschrijdingen in oppervlaktewater met de betreffende werkzame stoffen afkomstig is van gewasbeschermingsmiddelen. Daarnaast, en met name voor imidacloprid, vormen diergeneesmiddelen een belangrijke potentiële bron. De heersende opinie is dat het aandeel van biociden, gebaseerd op de vijf werkzame stoffen, klein is - hoewel niet noodzakelijkerwijs verwaarloosbaar.
- Er is een gebrek aan inzicht in de herkomst van werkzame stoffen wanneer hun aanwezigheid in oppervlaktewater is gedetecteerd. Verschillende geïnterviewden pleiten voor meer onderzoek op dit gebied.
- Potentiële emissie van insecticiden (als PT18-biocide) naar het oppervlaktewater vindt voornamelijk plaats door afspoeling of door uitspoeling (via het riool, via verspreiding uit mest, via de bodem of rechtstreeks). Daarnaast kan illegaal gebruik leiden tot emissies, bijvoorbeeld door het gebruik van restvoorraden van verboden middelen, door het gebruik van te hoge doseringen, door gebruik op niet-toegestane locaties, door (vroegtijdig) nat reinigen of door het lozen van overtollige spuitvloeistof of spoelwater in het riool.

- *Wat als goedkeuring wordt hernieuwd of ingetrokken?*

De laatste vraag is: wat zal het effect zijn van hernieuwde goedkeuring, beperkingen of een besluit om het gebruik van deze werkzame stoffen voor PT18-insecticiden volledig te verbieden (in de EU en/of in Nederland)?

De conclusies zijn:

- *Bij geen aanvullende beperkingen:* Als de goedkeuring wordt verlengd en er geen aanvullende beperkingen worden gesteld, zullen deze middelen worden verkocht en gebruikt zoals nu het geval is. Een voortzetting van de huidige situatie – met inbegrip van een voortzetting van het gebruik van deze stoffen in gewasbeschermings- en diergeneesmiddelen – zal de waterverontreiniging met deze werkzame stoffen niet verminderen, en mogelijk zelfs vergroten door de ophoping van persistente chemische stoffen. Hetzelfde geldt voor de vervuiling met PFAS. Het toepassen van dezelfde werkzame stoffen zal op de lange termijn waarschijnlijk leiden tot resistente plaagdiersoorten.
- *In het geval van een volledig verbod:* Een volledig verbod van deze insecticiden kan leiden tot een zekere vermindering van de risico's voor mens en milieu (inclusief risico's voor niet-doelsoorten en watervervuiling), hoewel het voortgezette gebruik van gewasbeschermings- en diergeneesmiddelen met deze werkzame stoffen nog steeds zijn (waarschijnlijk sterkere) effect zal hebben. Lambda-cyhalothrin (een PFAS) kan vervangen worden door een ander synthetisch pyrethroïde. Tegelijkertijd zullen de effecten zijn: een meer beperkte gereedschapskist voor professionele plaagdierbeheersers, wat kan resulteren in het onvermogen om bepaalde plagen te bestrijden, wat op zijn beurt kan leiden tot latere risico's zoals de verspreiding van ziektedragende insecten in de toekomst. Ook zal er een grotere afhankelijkheid zijn van minder beschikbare opties, waardoor de kans op resistentieopbouw toeneemt. Ook worden de marges voor producenten kleiner, waardoor er minder geld is voor innovatie in (laagrisico) chemische insecticiden. Een groeiende vraag naar niet-chemische alternatieven zou echter ook innovatie op dit gebied kunnen stimuleren.
- *In het geval van selectieve beperkingen:* Als een voortzetting van de huidige situatie ongewenst is en als een volledig verbod van deze insecticiden te veel negatieve neveneffecten heeft, kunnen bepaalde beperkingen worden overwogen, zoals:
  - Beperk het gebruik van deze werkzame stoffen in gewasbeschermings- en diergeneesmiddelen; er zijn aanwijzingen dat de risico's van het gebruik van deze producten groter zijn dan de risico's van het gebruik van PT18-insecticiden.
  - Onderzoek of werkzame stoffen die PFAS zijn of als metaboliet hebben, door de BPR kunnen worden verboden.
  - Verbied deze producten voor consumentengebruik. Consumenten hebben genoeg alternatieven om overlast en kleine plagen aan te pakken. In het geval van ernstigere plagen kunnen ze professionele plaagdierbeheersers inhuren. De kosten voor die inhuur kunnen consumenten er echter van weerhouden dit te doen (waardoor de plaag verergert). Een verbod kan ook leiden tot illegale invoer van niet-toegelaten insecticiden en tot het gebruik van huismiddeltjes (azijn, bleekwater).
  - Creëer een zekere barrière voor de verkoop van deze producten aan consumenten door de verkoop alleen toe te staan over de toonbank of op recept. Dit kan ook bijdragen aan de bewustwording van de risico's van deze producten.
  - Een certificeringseis invoeren voor agrarische gebruikers van insecticiden, alleen te behalen na bewijs van vakbekwaamheid (opleiding en examen), als voorwaarde voor het gebruik van insecticiden als biociden.
  - Voer een wettelijke verplichting in voor professionele gebruikers van insecticiden om de IPM-methode toe te passen, inclusief richtlijnen voor het gebruik ervan.
  - Vergroot het bewustzijn door middel van gerichte communicatie, zowel naar professionele gebruikers (inclusief agrariërs) als naar consumenten.
  - Stimuleer het gebruik van niet-chemische methoden, van preventieve maatregelen en van bestrijdingsmethoden met een laag risico (naast beperkingen op het gebruik van chemische producten). Dit zou de beschikbaarheid van alternatieven verder kunnen vergroten en de impuls om insecticiden te gebruiken voor alle gebruikersgroepen kunnen verminderen.
  - Doe meer metingen om bronnen van waterverontreiniging op te sporen (zo mogelijk met gebruik van markers).

1. Introduction

1.1 Background to the study

The Biocidal Products Regulation (BPR; EU/528/2012) requires that the approval of active substances for use in biocides is reassessed at regular intervals.[1] In the upcoming months and years the approval of 5 active substances that are used in insecticides, acaricides and products to control other arthropods (PT18)[2] will be reassessed. These 5 substances (and their respective approval dates) are:

- Cypermethrin (2018; approval until 31-5-2030)[3] (See also footnote 8)
- Alpha-cypermethrin (2015; approval until 30-6-2026)[4]
- Deltamethrin (2013; approval prolonged until 31-3-2026)[5]
- Imidacloprid (2013; approval prolonged until 31-3-2026)[6]
- Lambda-cyhalothrin (2013; approval prolonged until 31-3-2026)[7]

The decision-making on reapproval of active substances for biocides takes place in the Standing Committee on Biocidal Products (SCBP), which includes the Ministry of Infrastructure and Water Management (IandW) for the Netherlands. For its input into this process, as well as for several specific (partly national) purposes, IandW wants to have up-to-date insight into the use and replacement perspective of these substances.

These specific purposes are:

- All 5 substances are present in problematic limit-exceeding concentrations in Dutch surface waters. For the Water Framework Directive, two of them are priority substances (cypermethrin and alpha-cypermethrin).[8] Before 2039, their concentration in surface waters must be below the limit. The other three substances are characterised as 'specific polluting substances'; their deadline for meeting the limit is 2027.[9]
  A complicating factor for attempting to prevent this pollution is that these substances can originate from different types of products and uses. Besides as active substances in PT18 insecticides (used by professional pest controllers, agrarians and/or consumers), several of these substances are (or, in some cases, were) also applied in wood preserving biocides (PT8), in plant protection products and in veterinary medicines
- One of these substances, lambda-cyhalothrin, is a 'per- and polyfluoroalkyl' a.k.a. PFAS.[10] These substances are known for their extremely high persistence, hence their nickname 'forever chemicals'. Within REACH a restriction on PFAS is being prepared. This does not, however, include active substances for biocides.[11] For the latter, decision on restrictions must be made within BPR-context (for which the upcoming re-assessment may be the appropriate moment).

The present report has been prepared to serve the Dutch policy interests and to function as a knowledge document, describing the impact of reapproval, restriction or phasing out of these substances.

[1] In addition to the fact that the European Commission can reconsider an approval at any time based on new information)
[2] PT18: Product type 18. The BPR distinguishes 22 product types into 4 main groups. Product type is part of main group 2: pest control, and concerns products used for the control of arthropods (e.g. insects, arachnids and crustaceans), by means other than repulsion or attraction.
[3] Commission implementing regulation (EU) 2018/1130 of 13 August 2018 approving cypermethrin as an existing active substance for use in biocidal products of product-type 18
[4] Commission implementing regulation (EU) 2015/405 of 11 March 2015 approving alpha-cypermethrin as an active substance for use in biocidal products for product- type 18
[5] Commission implementing decision (EU) 2023/1088 of 2 June 2023 postponing the expiry date of the approval of deltamethrin for use in biocidal products of product- type 18 in accordance with Regulation (EU) No 528/2012 of the European Parliament and of the Council
[6] Commission implementing decision (EU) 2023/460 of 2 March 2023 postponing the expiry date of the approval of imidacloprid for use in biocidal products of product- type 18 in accordance with Regulation (EU) No 528/2012 of the European Parliament and of the Council
[7] Commission implementing decision (EU) 2023/1087 of 2 June 2023 postponing the expiry date of the approval of lambda-cyhalothrin for use in biocidal products of product-type 18 in accordance with Regulation (EU) No 528/2012 of the European Parliament and of the Council
[8] Alpha-cypermethrin is an enantiomer of cypermethrin, for which reason the two substances cannot be distinguished when detected in water measurements. This is also the reason why both substances are included in this study, even though cypermethrin is only up for reapproval in 2030 (and even though before recently no biocides based on cypermethrin were authorised for use in the Netherlands).
[9] RWS-WVL (2023): 'Memo Stoffenlijst KRW impuls'
[10] To be precise: both lambda-cyhalothrin and its metabolite TFA, are considered PFASs, according to the definition from 2021 by the Organisation for Economic Co-operation and Development (OECD).
[11] Information from Dutch Bureau REACH

1.2 Purpose of the study

The objective of the research project described here is as follows.

The aim of the project is:

- to map:
  - ✓ (what is known about) the current use and the hazards and risks of insecticides (PT18) based on the active substances cypermethrin, alpha-cypermethrin, deltamethrin, imidacloprid and lambda-cyhalothrin,
  - ✓ as well as (what is known of) the current use and the hazards and risks of articles that have been treated with these insecticides (treated articles),[12]
  - ✓ and what the replacement perspective is for these insecticides, respectively for these treated articles,
- and to make this knowledge available in a report to support Dutch policy makers' considerations in both the national context and within the SCBP.

1.3 Research questions

As the purpose of the study already indicates, the main question is: what is known about the current use, the hazards and risks and the replacement perspective of insecticides based on the active substances cypermethrin, alpha-cypermethrin, deltamethrin, imidacloprid and lambda-cyhalothrin, and of articles that have been treated with these insecticides? This main question has been elaborated in this project in the following sub-questions.

The question about the use and dangers and risks of these substances can be divided into several sub-questions:

- Which insecticides based on these active substances are currently authorised and for which specific applications?
- What is known about the current use of insecticides based on these active substances (and, if possible, also its historical development).
  - ✓ both qualitative (nature of application, field of application, function);
  - ✓ and quantitative (volumes)?
- What is known about the dangers and risks of using these products?

Questions about the use and dangers and risks of articles treated with insecticides based on these substances are:

- What is known about the nature and current use of these treated articles (and, if possible, also their historical development), both qualitative and quantitative?
- What is known about the dangers and risks of using these products?

The main question in relation to the surface water quality problem posed by these substances is:

- To what extent do historical, current and future use of these PT18 insecticides and treated articles contribute to the problems with surface water pollution? (Also in relation to the use of the 5 active substances in other types of products?).

The questions about the replacement perspective are informed by the Integrated Pest Management (IPM) principle. According to this principle, prevention and monitoring form the basis and the first step to prevent or control harmful organisms. If preventive measures prove insufficient, non-chemical measures are used as a second step. If these are also not sufficient, low-risk biocides are used. If this is not sufficient, biocides with an acceptable risk are used, and as a final step, a biocide that poses a risk and/or contains an undesirable substance.[13]

Answers to the following questions concerning the use of insecticides are important from a replacement perspective:

- To what extent are prevention and monitoring (or can they be) applied and effective to prevent or control insects, arachnids and crustaceans?

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[12] 'Treated articles' are articles that have been treated with biocides and that carry a biocidal claim. They are regulated in art. 58 of the BPR.
[13] Ministerie van Infrastructuur en Waterstaat (2023): *Strategisch kader voor de inzet van biociden bij het voorkomen en beheersen van ongewenste organismen*

- To what extent are low- and/or acceptable risk insecticides (or can they be) applied and effective to prevent or control insects, arachnids and crustaceans?
- Can the use of insecticides based on these 5 active substances be reduced?
- What drives and what prevents substitution?
  - ✓ What is the risk awareness of the various actors dealing with insecticides based on these 5 active substances?
  - ✓ What are drivers and motives for adapting alternatives and for preventing avoidable use? What are bottlenecks and barriers to adapting alternatives?
- What is the necessity of being able to use these insecticides for the different user groups?

Next, the following questions concern the use of articles that are treated with insecticides based on these 5 active substances (treated articles) from a replacement perspective:
- For what purposes are these treated articles used?
- What are alternative ways to realise these purposes, and to what extent can they substitute the articles that are treated with insecticides based on these 5 active substances?
- What drives and what prevents substitution of the treated articles?
  - ✓ What is the risk awareness of the various actors dealing with these treated articles?
  - ✓ What are drivers and motives for adapting alternatives? What are bottlenecks and barriers to adapting alternatives?

And the final question:
- What will be the impact of renewed approval, restrictions or a decision to completely ban (in the EU and/or in the Netherlands) the use of cypermethrin, alpha-cypermethrin, deltamethrin, imidacloprid and/or lambda-cyhalothrin as active substances for insecticides?

1.4 The approach of this study

• The approach in general terms

To answer the questions described above, a study was carried out in 5 steps. Two steps were aimed at data collection, namely the desk research in step 1 and the interviews in step 3. In intermediate step 2, a market chain analysis was carried out based on the insights obtained (“which parties play a role and where?”) and an interview strategy was set up (“with which of those parties do we want to talk about what?”). Several relevant government parties were consulted during this step to determine whether all relevant themes, data and parties were adequately covered. After the interviews in step 3, the data obtained were analysed and reported in a draft report (step 4). The final report was delivered in step 5.

Consultations took place with the commissioning body (IandW) at essential moments in the process: at the start of the project (start of step 1), at the end of step 2 and for a discussion of the draft final report (between steps 4 and 5).

Figure 1 below shows the broad outline of the approach used. The individual steps are explained in more detail in the following subsections.

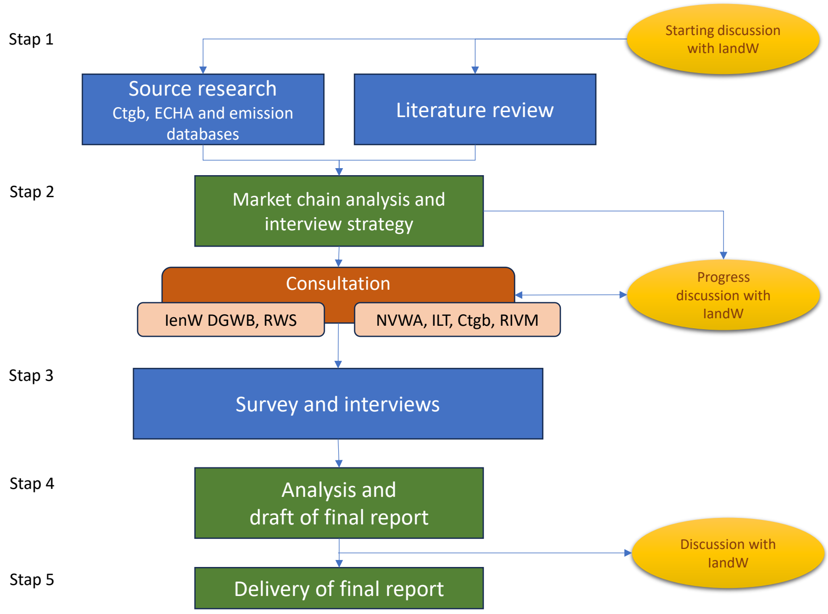

Figure 1: Broad outline of the research

- *Step 1: Desk research*

The desk research was carried out along two lines:

– The databases on the Ctgb and ECHA websites were searched for the approval of the 5 active substances and for the authorizations of PT18 insecticides based on these active substances. In particular, it has been mapped out:
  - ✓ who the producers/applicants are;
  - ✓ what the specific applications, intended uses are (including treated articles) and specific legal instructions for use; and;
  - ✓ any additional comments and opinions.

– The databases of the *'Atlas bestrijdingsmiddelen in oppervlaktewater'* ('Atlas of pesticides in surface waters')[14] and *'Emissieregistratie'* ('Emission registration')[15] were searched for data on emissions and concentrations of these substances in the environment.

– A literature search was carried out for relevant publications on, among other things, the substances, the insecticides based on these substances, chemical and non-chemical measures and innovations for prevention and control of insects, arachnids and crustaceans.

– Furthermore, a survey was conducted among EU Member States where traded volumes of biocides are registered (i.e. Belgium, Denmark, Finland, France, Croatia, Sweden). They were asked to provide available data on the traded (insecticides containing the) 5 active substances.

- *Step 2: Market chain analysis and interview strategy*

A chain analysis was carried out based on this information. It was mapped out who the upstream and downstream producers are, to which markets (and companies) they supply for which use, and which other (sector) organizations play a relevant role in this area and/or have relevant expertise.
It was also examined to what extent answers to the various research questions could already be distilled from the data obtained (for example about volumes and about hazard and risk properties). Any gaps in these answers and specific points of interest were taken into account when determining the interview strategy.

Based on the chain analyses, it was determined who are the relevant parties to be interviewed. Based on all this and the further research questions as stated above, an interview strategy was drawn up, including the question items to be addressed by the various players.

[14] See: Atlas Bestrijdingsmiddelen in oppervlaktewater; https://www.bestrijdingsmiddelenatlas.nl/atlas/1/1
[15] See: Alle emissiegegevens op één plek | Emissieregistratie; https://www.emissieregistratie.nl/

An overview of available and unavailable information and of parties to be interviewed was submitted to several government parties (IandW DGWB, RWS, NVWA, ILT, Ctgb, RIVM and commissioning body IandW).[16] This was to check completeness and with a view to possible additional search directions.

- *Step 3: Interviews*

The interview strategy was then implemented. Parties in all links of the production and application chain were approached (in some cases, umbrella organisations were approached to represent the users). The first approach took place by email, followed by either a written exchange of information or by a telephone, online or face-to-face interview.

In total, information was exchanged with the following types and numbers of parties involved. Appendix 1 to this report provides a further description.

Table 1: Numbers and types of consulted parties

	Number of interviewed persons	Number consulted in writing
Producers / authorization holders (Including producers of alternatives)	5	5
Applicants / umbrella organizations of applying sectors (commissioning organisations, pest control and agrarians)	11	6
Trading companies organisations (wholesale and retail)	4	
Education and training institutes	2	
Experts (e.g.: on water quality)	4	
NGO's	3	2

Global (not verbatim) reports were made of the interviews. If so required, respondents were sent the interview reports for approval.

- *Step 4 and 5: Final reporting*

Based on all this, an overall analysis was carried out and a draft version of the present report was drawn up. This was submitted to the ministry of IandW. After questions and comments were processed, the present final report was sent to IandW for approval.

1.5 Reading Guide

The remainder of this report is structured as follows:

- The next chapter (2) describes the most important results of the desk research. It describes what is known about the functional and hazardous properties of cypermethrin, alpha-cypermethrin, deltamethrin, imidacloprid and lambda-cyhalothrin, for which applications and which target organisms PT18 insecticides based on these active substances are authorised and what is known about the nature and size of the current market.
- In Chapter 3, it is described what use is made of insecticides based on the 5 substances by respectively professional pest controllers, agrarians and consumers, and which risks are associated with these uses. Also, the risk awareness of these groups is described. Furthermore, it is examined which alternatives are available for these purposes and to which extent they are applied by the different user groups. The final paragraph of chapter 3 is dedicated to a description of what is known about the use of the substances for treating articles, notably textiles.
- Chapter 4 looks into the water pollution by these substances and the extent to which this can be associated with the use in PT18-insecticides.
- Chapter 5 draws conclusions from all this, and in particular about the question of what the impact will be of re-approval, of restrictions or of a decision to completely ban insecticides based on cypermethrin, alpha-cypermethrin, deltamethrin, imidacloprid and lambda-cyhalothrin in the EU and/or in the Netherlands.

[16] DGWB = Directoraat Generaal Water en Bodem ('Directorate General for Water and Soil'), RWS = Rijkswaterstaat ('Directorate General for Water Management'), NVWA = Nederlandse Voedsel- en Warenautoriteit ('Netherlands Food and Consumer Product Safety Authority'), ILT = Inspectie Leefomgeving en Transport (Human Environment and Transport Inspectorate'), Ctgb = College voor de toelating van gewasbeschermingsmiddelen en biociden ('Dutch Board for the Authorisation of Plant Protection Products and Biocides'), RIVM = Rijksinstituut voor Volksgezondheid en Milieu ('National Institute for Public Health and the Environment')

The appendices contain an overview of sources that were consulted (appendix 1) and an overview of the authorizations for insecticides based on cypermethrin, alpha-cypermethrin, deltamethrin, imidacloprid and lambda-cyhalothrin (appendix 2).

2. Properties, application, and market data

2.1 Introduction

This chapter describes, mainly based on desk research:

- What is known about the functional and hazard properties of cypermethrin, alpha-cypermethrin, deltamethrin, imidacloprid and lambda-cyhalothrin (section 2.2). This mainly concerns data of a scientific nature that have largely been known and established for a longer time. The description in this chapter is therefore largely based on scientific literature, the assessment reports of the evaluating competent authorities and opinions of the Biocidal Product Committee (BPC);
- For which applications in PT18 these active substances are authorised (section 2.3). Current data on this are taken from the websites of ECHA and Ctgb (reference date March 1, 2025);
- What else is known about the nature and size of the current market (section 2.4).

2.2 Properties

2.2.1 Functional properties

The substances studied are all currently approved for the use in product type 18. All of the five fulfil some criteria to be considered a candidate for substitution (CfS). Candidates for substitution meet at least two criteria for being PBT[17] (article 10 of the BPR). Imidacloprid and lambda-cyhalothrin are marked as CfS, due their classification as both toxic as well as very persistent and bioaccumulative, respectively. [18] Candidates for exclusion are either classified as carcinogenic, mutagenic, reprotoxic or endocrine disruptive and/or fulfil the criteria for being PBT or vPvB[19] (article 5 of the BPR). None of the substances studied, fulfil the criteria for exclusion. These classifications are summarized in table 2 below.

Table 2: Summary of main properties of the five active substances studied

Active substance	CAS-no.	Class	Criteria for substitution fulfilled	Candidate for substitution	Candidate for exclusion
Cypermethrin	52315-07-8	Synthetic pyrethroid	Toxic	No	No
Alpha-Cypermethrin	67375-30-8	Synthetic pyrethroid	Toxic	No	No
Deltamethrin	52918-63-5	Synthetic pyrethroid	Toxic Potentially Persistent	No	No
Imidacloprid	138261-41-3	Neonicotinoid	Very Persistent Toxic	Yes	No
Lambda-cyhalothrin[20]	91465-08-6	Synthetic pyrethroid	Bioaccumulative Toxic	Yes	No

- *Cypermethrin, alpha-cypermethrin, deltamethrin and lambda-cyhalothrin*

Cypermethrin, alpha-cypermethrin, deltamethrin and lambda-cyhalothrin are all part of the group of synthetic pyrethroids and are used as insecticides. Pyrethrins (mainly pyrethrum) are naturally occurring substances, extracted from the chrysanthemum flower and have historically been used as insecticides. In the 20th century, synthetic pyrethroids have been developed which are similar to, but more chemically stable than the naturally occurring pyrethrins. After the intensive use of DDT (dichlorodiphenyl trichloro-ethane) in the 1950s and 1960s, synthetic pyrethroids substituted the role of DDT and have been frequently implemented as effective insecticides (Davies, 2008; RIVM, 2023a). Synthetic pyrethroids are used to control agricultural pests as well as non-agricultural insects, such as ants, lice and mosquitoes, as well as ticks and spiders (Singh, 2022).

[17] PBT: Persistent (hardly degradable in the environment), Bioaccumulative (accumulation of the substance in organisms) and Toxic (toxic to humans and/or ecosystems)

[18] According to the substance information list of the Coordination Group: Circabc; https://circabc.europa.eu/ui/group/e947a950-8032-4df9-a3f0-f61eefd3d81b/library/7149b88b-d49c-4f42-ae76-0e37f1aeafb0/details

[19] vPvB: very Persistent and very Bioaccumulative

[20] Lambda-cyhalothrin and its metabolite trifluoroacetic acid (TFA) are PFASs. PFASs, including TFA, are generally barely biodegradable. Lambda-cyhalothrin is not labelled as persistent, since this substance is biodegradable (to, amongst others, TFA). During the previous assessmentof lambda-cyhalothrin, the metabolite TFA has been declared to be of no human toxicological relevance.

The mode of action of both the pyrethrins, pyrethroids and DDT is the same: through the voltage-gated sodium channels, known as 'para'-channels. Pyrethrins, pyrethroids and DDT function as neurotoxins, binding to these 'para'-channels in neurons, causing the neurons to fire rapidly and continuously, resulting in tremors and paralysis (hence the name 'para'). At low dosages, the chemicals lead to a stable, paralysed phase in the insect called 'knockdown'. Higher concentrations and/or specific characteristic chemical groups in the pyrethroids lead to a higher killing rate of the insects (Davies, 2008).

Synthetic pyrethroids are acids, which are strongly lipophilic. Because of these polar and lipophilic properties, these substances can rapidly penetrate the bodies of many insects and disturb their nervous system (Verma, 2024). Where the naturally occurring pyrethrins are prone to break down due to sunlight, the synthetic pyrethroids are altered to be more stable and thus yield a longer residence time in the environment and thus in organisms (Soderlund, 2008; Davies, 2008; Singh, 2022).

Formulations of synthetic pyrethroids generally consist of a mixture of multiple isomers of the same molecule (stereoisomers). Depending on its molecular structure, each pyrethroid may have multiple potential isomers. For example, cypermethrin is composed of eight distinct isomers consisting of 4 pairs of stereoisomers, that can also separately be used as active substances (inter alia alpha-cypermethrin), each with its own toxicological effects (Singh, 2022). Deltamethrin has 8 isomers as well, but in practice the technical mixture will consist mainly of 1 (cis) isomer, as a consequence of a selective preparation process (Verma, 2024).

- *Imidacloprid*

Imidacloprid is part of the group of neonicotinoids, which have been widely used since the 1990s. It is a broad-spectrum neurotoxic insecticide and is used for the protection of crops, in veterinary medicinal products and for the control of insect pest populations. They are systemic insecticides, meaning that they are taken up by the plant and translocated throughout the plant, leading to toxicity in the gut of the herbivorous insects (Simon-Delso, 2015, Bass, 2015).

Neonicotinoids act as copycats to neurotransmitters in the central nervous system of the insect, binding the nicotinic acetylcholine receptor. Doing so, they continuously stimulate the neurons, disturbing the transmission of signals, leading to paralysis of the insect and eventually resulting in death of the insect within a few hours (Plumlee, 2004; Simon-Delso, 2015).

Besides its insecticide action, imidacloprid has also been shown to stimulate certain plant growth, even in the absence of damaging pests, leading to increased crop yield (Simon-Delso, 2015). Imidacloprid has previously been used as plant protection product (PPP) and was applied through seed coating or by spraying. Use of imidacloprid in PPP has been banned in the EU since 2020 (expiry date end of 2021).

2.2.2 Hazardous properties for human health

Table 3: summary of hazardous properties for human health according to the harmonized Classification and Labelling[21]

Active substance	Acute toxicity	Specific target organ toxicity (STOT)	Skin	Properties of concern[22]
Cypermethrin	Harmful if swallowed	May cause respiratory irritation	Causes skin irritation May cause an allergic skin irritation	Skin sensitizing Under assessment as Endocrine Disrupting
Alpha-cypermethrin	Toxic if swallowed	May cause respiratory irritation May cause damage to organs through prolonged or repeated exposure	-	-
Deltamethrin	Toxic if swallowed Toxic if inhaled	-	-	Possible skin sensitizing

[21] According to the C&L Inventory, available through each respective Substance infocard by ECHA: https://echa.europa.eu/nl/information-on-chemicals
[22] According to each respective Substance infocard by ECHA: https://echa.europa.eu/nl/information-on-chemicals

Active substance	Acute toxicity	Specific target organ toxicity (STOT)	Skin	Properties of concern[22]
Imidacloprid	Toxic if swallowed	-	-	Under assessment as Endocrine Disrupting
Lambda-cyhalothrin	Harmful if swallowed Harmful in contact with skin Fatal if inhaled	-	-	-

- *Cypermethrin, alpha-cypermethrin, deltamethrin and lambda-cyhalothrin*

The acute toxicity of synthetic pyrethroids is much higher to insects than to mammals, because of the high selectivity of these compounds towards insects (RIVM, 2023a). This is due to limited absorption by the skin and inhalation in mammals on the one hand and rapid biodegradation by mammalian livers on the other hand. Insects do not have this liver function and thus are more susceptible to its acute toxic effects (Beyond Pesticides, 2023).

However, synthetic pyrethroids may still negatively affect mammals including humans. Pyrethroids may have irritant and or sensitizing properties. They are not easily absorbed through the skin, but are absorbed through the gut and pulmonary membranes, eventually leading to systemic toxicity. Systemic toxicity in mammals due to pyrethroids may lead to carcinogenic, neurotoxic, immunological effects and also may negatively affect lymphoid cells, the lungs, liver, kidneys and reproductive organs (Singh, 2022; RIVM, 2023a).

Anecdotal evidence showed that high concentrations of pyrethroids may lead to a wide range of undesirable effects such as burning sensations, numbness or stiffness in the mouth, runny noses, coughing, sneezing, abnormal face feelings, dizziness, weariness and skin rashes (Singh, 2022). There are also indications of mutagenic effects of pyrethroids, leading to the suspicion of deltamethrin (and other pyrethroids permethrin and fenvalerate) as potential carcinogen for humans (Singh, 2022, see also references in RIVM, 2023a). They are currently not labelled as such under CLP (Classification, Labelling and Packaging regulation[23])[24].

According to the respective Assessment Reports (further: AR) of the four synthetic pyrethroids studied, some may be irritating and sensitizing to the skin (e.g. lambda-cyhalothrin) and/or respiratory tract (e.g. cypermethrin). However, they are not always labelled as such under CLP.

Furthermore, the Assessment Report of cypermethrin (2024) describes that cypermethrin may act as an estrogen-like chemical and thus may function as an endocrine modulator. Though currently there is not sufficient data to conclude either way. Of the four synthetic pyrethroids, only cypermethrin is currently under assessment as endocrine disruptor[24] and will be reassessed during the renewal of cypermethrin for PT8 and PT18 (AR Cypermethrin 2024). In 2022, NGO PAN-Europe, has submitted a formal complaint to the Court of Justice of the EU. The aim is the withdrawal of the approval of cypermethrin because of issues with the endocrine disrupting and the genotoxic properties of the substance that were identified by the European Food Safety Authority (EFSA). PAN-Belgium and PAN-NL in 2023 also formally asked the Belgian Council of State and Ctgb respectively to withdraw the authorisations of biocide formulations with cypermethrin.25 The appeal in both countries is still pending.

[23] CLP-Regulation (EC) No 1272/2008
[24] If classified as carcinogenic, mutagenic, reprotoxic or endocrine disruptive, the compound would fulfil the criteria for classification for exclusion under the BPR.
[25] See: https://www.pan-europe.info/press-releases/2022/09/pan-europe-takes-legal-action-against-cypermethrin-highly-hazardous-pesticide; https://www.pan-netherlands.org/blog/2023/03/09/verzoek-tot-intrekking-van-drie-gevaarlijke-insecticiden/; https://www.pan-europe.info/blog/cypermethrin-reason-challenge-belgiums-authorisation-system-toxic-pesticides-national-court

Imidacloprid

Imidacloprid is generally perceived as safe for mammals and humans, because of its high specificity for the insect-acetylcholine receptor, which is more prevalent in insects than in mammals.

Imidacloprid and other neonicotinoids are rapidly taken up in humans through the intestines (Simon-Delso, 2015). Different from insects, the substance is then rapidly metabolized in the liver and excreted, leading to moderate toxicity in humans. Through the dermal and inhalation routes, minimal toxicity is reported. Acute exposure through ingestion can cause salivation or vomiting. Other than that, toxic effects only occur in humans at extremely high concentrations (Plumlee, 2004). Imidacloprid is not an irritant and does not produce evidence of dermal sensitization. Imidacloprid is not carcinogenic, mutagenic or reprotoxic (AR Imidacloprid, 2015). Imidacloprid is currently under assessment as endocrine disrupting[24].

2.2.3 Hazardous properties for the environment

Biocides with the active substances studied, may be released into the environment during production, processing, storage, use and disposal of the formulations and of the treated articles. Releases would mainly enter the aquatic compartment (incl. sediment) and the soil (incl. groundwater).

All five of the substances studied are classified as both very toxic to aquatic life (Aquatic Acute 1) and very toxic to aquatic life with long lasting effects (Aquatic Chronic 1) under CLP.

Table 4: summary of hazardous properties for the environment according to the harmonized Classification and Labelling[26]

Active substance	Aquatic acute	Aquatic chronic
Cypermethrin	very toxic to aquatic life	very toxic to aquatic life with long lasting effects
Alpha-cypermethrin	very toxic to aquatic life	very toxic to aquatic life with long lasting effects
Deltamethrin	very toxic to aquatic life	very toxic to aquatic life with long lasting effects
Imidacloprid	very toxic to aquatic life	very toxic to aquatic life with long lasting effects
Lambda-cyhalothrin	very toxic to aquatic life	very toxic to aquatic life with long lasting effects

- *Cypermethrin, alpha-cypermethrin, deltamethrin and lambda-cyhalothrin*

Behaviour and fate in the environment

Upon entering the environment, most synthetic pyrethroids will be mainly degraded by photolysis (direct sunlight) or by hydrolysis. However, of these four, deltamethrin is not susceptible to abiotic degradation (including photolysis) under normal environmental conditions (AR Deltamethrin, 2011). In addition, absorption into the sediment will increase the half-life of the pyrethroids due to limited exposure to sunlight.

Due to their hydrophobic properties, synthetic pyrethroids that enter the environment will quickly adsorb to sediments and other organic matter (AR Deltamethrin, 2011; AR cypermethrin, 2024). In both the environment and in organisms these substances will bind to organic matter and other fatty tissues, leading to persistence (a range of several days) and thus bioaccumulation (RIVM, 2023a; BPC opinion cypermethrin, 2017; AR Alpha-cypermethrin, n.d.).

Effects on non-target species

Pyrethroids are generally very harmful to most aquatic life. Of the four pyrethroids studied, deltamethrin is the most harmful. The pyrethroids are both acutely and chronically toxic to fish and aquatic invertebrates. (AR Deltamethrin 2011; AR Cypermethrin, 2024) Generally, pyrethroids have sublethal effects on fish, of which mainly damage of the gills, where the substances are absorbed and metabolized (Singh 2022; RIVM, 2023a).

Pyrethroids furthermore act not only on the unwanted pests, but also affect insects that are perceived as beneficial such as bees. Due to the absence of a liver, insects exhibit a greater susceptibility to the substances than mammals (Beyond Pesticides 2023). Both sub-lethal and lethal concentrations are suspected of contributing to the worldwide decline of bee populations. Also, other invertebrates may be affected, leading to disturbances in food webs and biodegradation cycles, e.g. speeding up the metamorphosis of aquatic organisms, resulting in less food for amphibians, reptiles, and birds (Singh, 2022, Beyond Pesticides 2023).

[26] According to the C&L Inventory, available through each respective Substance infocard by ECHA: https://echa.europa.eu/nl/information-on-chemicals

- *Imidacloprid*

Behaviour and fate in the environment

Upon entering the environment, imidacloprid will remain in the environment for weeks to several months (Gervais et al., 2010; Simon-Delso, 2015). Sorption of imidacloprid to soil generally increases with soil organic matter content, though is also dependent on other parameters such as pH, soil-type and presence of degrading microorganisms. Imidacloprid may be broken down by photodegradation, hydrolysis and, as said, by microbes (Gervais et al., 2010; AR Imidacloprid, 2015; Pang, 2020). Imidacloprid is moderately mobile in soil and this depends on the amount of dissolved organic carbon in the soil to which it adsorbs (Gervais et al., 2010; AR Imidacloprid, 2015). Furthermore, imidacloprid is generally not considered to be persistent or bioaccumulative in aquatic or terrestrial life because of its relatively low lipophilicity (AR Imidacloprid, 2015).

Effects on non-target species

Imidacloprid is of low toxicity to fish and other aquatic life, except for aquatic insects (AR Imidacloprid, 2015). Its sublethal effects on fish include deformities, reduced growth, and organ damage (liver, gills and kidneys) (Pang, 2020).

Imidacloprid is generally (very) toxic to non-target insects and other invertebrates. It is for example very toxic to earthworms (Pang, 2020) and honey-bees (Simon-Delso, 2015). Imidacloprid and neonicotinoids in general have a high specificity to insects, because there is a higher concentration of nicotinic acetylcholine receptors in insect nervous tissue than in that of mammals. In addition, imidacloprid has a higher affinity for insect receptors than for vertebrate receptors (Plumlee, 2004, Simon-Delso, 2015). Furthermore, imidacloprid appears specifically toxic to bees, due to the presence of two types of the acetylcholine receptor in bees, resulting in the disturbance of both neuronal pathways in the brain and in the antennae, even at very low dosages (Simon-Delso, 2015). In addition, the metabolites of imidacloprid olefin and 5-OH-imidacloprid, lead also to delayed toxicity in the brain and thorax, leading to lethality in the bees that have survived the first exposure. It is expected that this delayed toxicity is also present in other insect-species, since the biotransformation pathway is similar in e.g. fruit flies and houseflies (Simon-Delso, 2015).

Furthermore, there is a growing body of evidence that persistent, low concentrations of these neonicotinoids in the environment pose serious risks of undesirable environmental impacts (Simon-Delso, 2015). These risks are due to their wide application, systemic properties in (crops and wild) plants, their broad spectrum of toxicity in invertebrates, and the persistence and environmental fate that renders them potentially harmful to a broad range of non-target organisms. The review by Chagnon et al. (2014) argues that the complex soil ecosystem may be disrupted by the presence of neonicotinoids due to decreasing inputs and activities of interacting diverse and functional biological communities. The stability of soil ecosystems is linked to biodiversity and especially the relative abundances of keystone species such as earthworms. Indeed, this link between adverse effects of neonicotinoids in the environment on organisms and ecological function was observed in a few field studies: among these are studies concerning microbes, beetles and earthworms were imidacloprid caused reduced soil nutrient cycling. Also long-term field studies have shown aquatic food chain effects, impeding nutrient cycling in aquatic environments, leading to reductions in survival, growth, and reproduction of freshwater organisms, altering the basis of the aquatic ecosystem (Chagnon et al., 2014). The specific effects on pollinators (such as bees) includes a possible cascade of effects in pollinator communities that can ultimately affect human populations due to reduced food security (Chagnon et al., 2014).

- *Aquatic quality standards*

In the authorization procedure for active substances for biocides, an environmental quality limit, the authorization criterium (in Dutch: toelatingscriterium) is used in the environmental risk assessment. This is the Predicted No-Effect Concentration (PNEC), and its derivation is based on Regulation 528/2012 (until 2012 Directive 98/8/EC). These standards apply to all biocide-receiving waters including ditches, and larger waters such as rivers or even marine waters. The derivation of the PNECaquatic takes into account, along with other things, that the substances degrade in the environment, through various routes such as photolysis and hydrolysis and also that there may be short-term effects on the most sensitive species.

On the other hand, there are also national water quality standards as a result of the Water Framework Directive (WFD)[27]. Under this Directive, two types of quality standards are established to ensure good water quality: AA-EQS (annual average environmental quality standard) and MAC-EQS (maximum allowable concentration environmental quality standard). Cypermethrin is listed as a priority substance in the WFD, where no distinction is made between cypermethrin and its individual isomers (thus it includes alpha-cypermethrin). Priority substances need to be addressed as a priority across Europe. The European Commission has established environmental quality standards for priority substances. Specific polluting substances (among which are deltamethrin, lambda-cyhalothrin and imidacloprid) are substances that are not of importance throughout the whole of Europe and for which Member States set their own water quality standards.

The environmental standards of the BPR and WFD are not in agreement with each other. This is due to:

- The endpoints forming the basis of the AA-EQS and PNECaquatic, differ between these environmental standards. The authorization criterion allows for short-term effects on the most sensitive species. While the WFD standard assumes no effect on species and all effects;
- Also, during the derivation of the WFD-standard, different assessment factors (safety factors) are used than for the derivation of PNECaquatic;
- Additionally, most of the studies used in the WFD are not part of the biocide dossier (AR Cypermethrin, 2024). For the derivation of the AA-EQS, all available ecotoxicity data, based on the No-Effect-Concentration (NOEC) of the substance and for as many different groups of aquatic organisms as possible is used, whereas the biocide dossier contains only the required research submitted by the applicant.

The study by Lahr et al. (RIVM, 2023a) listed the different background for the authorization criteria and chronic water quality standards for multiple pyrethroids. For example the authorization criterion for deltamethrin is based on a chronic insect study with an assessment factor of 5, while its EQS is based on an acute crustacean study with 100 as assessment factor.

The different standards lead to the situation that active substances may end up in the environment as a result of use in a biocidal product or treated article that complies with its admission rules, while this presents an exceedance of the WFD standards. The differences between the standards are a factor 10 to 230 for the synthetic pyrethroids, see table 5 below. Processes are currently underway to align these standards.

Table 5: aquatic quality standards. All values in ng/L[28]

Active substance	WFD		BPR
	AA-EQS*	MAC-EQS**	PNEC ***
Cypermethrin	0.08	0.60	4
Alpha-cypermethrin	0.09	-	4.8
Deltamethrin	0.0031	0.031	0.7
Imidacloprid	8.3	200	4.8
Lambda-cyhalothrin	0.020	0.47	0.20

* AA-EQS = annual average value-environmental quality standard
** MAC-EQS = maximum acceptable concentration-environmental quality standard
*** PNEC = predicted no-effect concentration (authorization criterium)

Synthetic pyrethroids have a large impact on the environment and surface water quality in particular because of their great potency, which again is due to their high selectivity towards insects and effects in aquatic organisms. These pyrethroids therefore are assigned with extremely low environmental quality standards in the WFD.

Several of these low AA-EQS, as reported in the table above, are considered non-evaluable, meaning that the reporting limit is higher than the standard value. This is the case for cypermethrin (including alpha-cypermethrin), deltamethrin and lambda-cyhalothrin. It is also sometimes the case for imidacloprid, however, only in a few cases. The reporting limit is the lowest value that can be reliably determined. In the Netherlands, regular monitoring of surface water quality is reported in the Dutch pesticide atlas (BMA).[29] This atlas provides insight into relations between local land use and limit exceedances in surface waters, based on measurement

[27] Water Framework Directive, Directive 2013/39/EU
[28] Sources: RIVM report 2023-0419 and https://rvszoeksysteem.rivm.nl/Stoffen. PNEC from respective Assessment Reports
[29] See: https://www.bestrijdingsmiddelenatlas.nl/atlas/1/1.

data from regional water managers. However, if the active substance is not found and thus not reported as exceedance in the BMA, no statement can be made as to whether the substance is present. This group of substances is therefore also called non-evaluable substances. If the substance is found, the standard is by definition exceeded. More on the monitoring and interpretation measurements of these substances in surface water is found in paragraph 4.2.

2.2.4 Resistance development

- *Cypermethrin, alpha-cypermethrin, deltamethrin and lambda-cyhalothrin*

The most common form of resistance against pyrethroids and DDT is the so-called knockdown resistance (*kdr*), with knockdown referring to the stable state of paralysis. This type of resistance concerns cross-resistance to the entire class of pyrethroids, pyrethrins and DDTs and has been observed and studied for more than 70 years (Soderlund, 2008). The resistance has been observed in a wide range of insect taxa, including in Europe (Soderlund, 2008; ECDC, 2023; AR cypermethrin, 2024).

The mode of resistance to pyrethroids in all arthropods is expected to be a modification of the para-channel, reducing its sensitivity to pyrethroids (Soderlund and Knipple, 2003; Davies, 2008). Multiple mutations are directly or indirectly linked to knockdown resistance, sometimes enhancing its resistance (Soderlund, 2008; Davies, 2008; ECDC, 2023). The *kdr*-trait does not diminish the efficacy of other insecticide classes (Soderlund and Knipple, 2003).

Mosquitos

The *kdr*-trait and resulting resistance is widespread in many countries in Africa (Zhu, 2016). The kdr-trait has also been found in multiple insect populations and several insect-species in Europe (Zhu, 2016; ECDC, 2023, Roca-Acevedo 2023). Especially mosquitos (e.g. *Aedes* and *Culex* species) are investigated because of their ability to transfer vector-borne diseases such as malaria, dengue and zika. Populations that are resistant to one or more substances of the pyrethroid class and/or DDT have been found all over Europe and neighbouring countries such as Armenia and Lebanon. Most of the research in the EU into resistant populations is from countries around the Mediterranean Sea (ECDC, 2023).

Monitoring of resistance to active substances is not nationally carried out in the Netherlands, and from surrounding countries, only from Belgium, UK and France little data is available. Pyrethroid-resistant mosquito populations have been found in France, Switzerland and Belgium (ECDC, 2023). However, the available data from the EU-countries is sparse in terms of time and space. Therefore, it is difficult to get a clear view of the current situation in NL or EU regarding current pyrethroid resistance. Resistance in wild mosquito populations across the EU/EEA seems to be increasing. Also outside of Europe, biocide resistance in vector mosquito species is a growing problem (ECDC, 2023).

Other insects

Resistance in other insect species can also occur and is usually also *kdr*-associated, though related research in other insect species is even more sparse than in mosquitos. Resistant populations are found all over the globe, and also in the EU:

- For flies, e.g. the common housefly, resistant populations are present in surrounding countries in the EU such as Denmark, UK and Germany (Roca-Acevedo, 2023);
- Resistant bed bugs have been found in urban areas around the globe, where they may pose a health concern (Lee, 2025). An example is the emerging and increasing resistance against pyrethroids in bedbugs in the United States over the past three decades (Lewis, 2022). Resistance-conferring genes have also been found in several European populations, including the Czech Republic, France and Switzerland (Durand, 2012;

Balvin, 2018). Resistance of bed bugs against pyrethroids is even named ubiquitous by researchers (Zhu, 2016);
- For cockroaches, pyrethroid-resistant populations have been found in the EU (Zhu, 2016; Šimunac, 2024).

Evidence of resistance in other insect species, such as in ants, spiders and woodlice in the EU is sparse and/or was not found at all. It is argued that in social insects, such as ants, occurrence of resistance should be rare because of the way reproduction is organized (Scharf and Lee, 2024).

- *Imidacloprid*

Insect resistance to neonicotinoids including imidacloprid has been reported in literature, including cross-resistance within the group of neonicotinoids (e.g. Simon-Delso, 2015). Resistance among multiple insect species such as the common housefly has been rising since the beginning of the 2000's and is increasing still (Bass, 2015).

The mode of action of the resistance is through either the presence of modifications in the subunit of the Acetylcholine receptor (to which imidacloprid then would no longer bind), or through accelerated metabolism of imidacloprid (Bass, 2015; Matsuda, 2020)

Resistance to imidacloprid has been observed around the globe in the common house fly and has also been reported in several populations in Europe (Markussen, 2010; Matsuda, 2020). No reports of resistance in Dutch populations have been found.

For both ants and cockroaches, no evidence of resistant populations in the EU was found.

2.3 Approved substances and authorized products

2.3.1 Approved active substances

The table below presents a summary of the conditions under which the active substances are approved for the EU market in their respective implementing regulations.

Table 6: Summary commission implementing regulations for the active substances

Active substance	EU regulation	Period of approval	Specific conditions for authorization	Other criteria
Cypermethrin	2018/1130	June 1st 2020 - May 31st 2030	Conditions for biocidal products (amongst others): product assessment shall pay particular attention to (environmental) exposures	Purity: ≥ 92 % w/w Isomeric ratio: *cis:trans* 40:60
Alpha-cypermethrin	2015/405	July 1st 2016 - June 30th 2026 *Renewal in progress (BE)*	Conditions for biocidal products: to prevent exposure to professionals and aquatic compartment)	Purity: 930 g/kg Sum of the isomers in a 1:1 ratio
Deltamethrin	Directive 2011/81 And Regulation 2023/1088	September 30th 2015 - September 30th 2023, postponed to March 31st 2026 *Renewal in progress (SE)*	Conditions for biocidal products: Indoor use may not be allowed unless data are submitted demonstrating that the product will meet the stated emissions requirements	Purity: 985 g/kg
Imidacloprid	Directive 2011/69 And Decision 2023/460	June 30th 2015 - June 30th 2023, postponed to December 31st 2025 *Renewal in progress (Du)*	Conditions for biocidal products (amongst others): use in animal housing may not be allowed unless data are submitted demonstrating that the product will meet the stated emissions requirements	Purity: 970 g/kg
Lambda-cyhalothrin	Directive 2011/80	September 30th 2015 - September 30th 2023, postponed to March 31st 2026 *Renewal in progress (GR)*	Conditions for biocidal products (amongst others): uses leading to emissions on STPs may not be allowed unless data are submitted demonstrating that the product will meet the stated emissions requirements	Purity: 900 g/kg

Of the five substances, cypermethrin also is approved for the use in PT8. Additionally, cypermethrin, deltamethrin and imidacloprid are also allowed and used in veterinary medicine, as spot-on treatments or in animal collars[30]. The active substances cypermethrin, deltamethrin and lambda-cyhalothrin[31] have an allowed application as well in plant protection products[32]. Imidacloprid has previously been used in plant protection products but no more after 2021 including the use-up period. The five active substances are not used in human medicines.[30]

Table 7: Summary of other uses of the 5 active substances

Active substance	Approved for Product Type	Veterinary medicinal product in NL	Currently authorized Plant protection products in NL (source: Ctgb)
Cypermethrin	PT8: 0 authorized in NL (2 products prior to 2016)* PT18: see table 8	1 *Spot-on application for sheep*	2 with expiry date in 2027
Alpha-cypermethrin	PT18: see table 8	0	0 (and 1 prior to 2001)
Deltamethrin	PT18: see table 8	17, of which 5 cancelled *Treated dog collars* *Spot-on application for dogs* *Spot-on application for cattle and sheep*	12 with expiry date in 2027 (and 25 prior to 2025)
Imidacloprid	PT18: see table 8	110, of which 21 cancelled *Spot-on application for dogs and cats* *Treated collars for dogs and cats*	0 (and 14 prior to 2021)
Lambda-cyhalothrin	PT18: see table 8	0	1 with expiry date in 2027 (and 14 in January 2025)

* Next to 79 products that are currently authorized in the EU, according to the ECHA database, of which the treated articles can be imported into the Netherlands.

2.3.2 Authorized biocidal products and application

A biocidal product is a product with an active substance that is intended to destroy, deter, render harmless, prevent the action of, or otherwise exert a controlling effect on harmful or undesired organisms. In the case of PT18 these products are either formulations with (possibly) a high concentration of the active substance that is placed on the market for use by professionals, formulations with lower concentrations of the active substance to be used by either professionals or non-professionals and treated textile carrying the biocidal intent for use by non-professionals.

Table 8 below present a summary of the use of biocidal products in PT18 based on the five active substances and the conditions under which the biocidal products may be authorized for the EU market, based on the Ctgb and ECHA databases, with reference date June 4th, 2025.

Table 8: Summary of biocidal products in PT18

Active substance	Type of product/ typical use	Professional/ non-professional	Target locations	Target species	Number of authorized biocidal products in NL
Cypermethrin	Dusting powder	Both	Indoors; outdoors; crack and crevice treatment	Ant, cockroach, crawling insects, wasp and wasp nests	1
Alpha-cypermethrin	Suspension concentrate	Both	Indoors; animal housing	Ant, mosquito, fly, wasp, cockroach	2

[30] According to the database of CBG: https://www.cbg-meb.nl/
[31] Plant protection products based on lambda-cyhalothrin are being withdrawn from the market.
[32] According to the database of Ctgb: https://toelatingen.ctgb.nl/nl/authorisations

Active substance	Type of product/ typical use	Professional/ non-professional	Target locations	Target species	Number of authorized biocidal products in NL
Deltamethrin	Dusting powder, aerosol spray, suspension concentrate, suspension capsule, ready-to-use spray, mosquito net, fogging	Both	Indoors; outdoors; crack and crevice treatment; animal housing*	Ant, mosquito, woodlice, cockroach, wasp and wasp nests, fly, bed bug, spider, silverfish, crawling insects	18
Imidacloprid	Attractant (ready to use bait box), water-dispersible granules	Both	Indoors; outdoors; crack and crevice treatment; animal housing	Ant, fly, cockroach	11
Lambda-cyhalothrin	Granules, suspension capsule	Both	Indoors; outdoors; animal housing	Ant, fly	2

* for one product[33] the use is quite specific: "up to 200 meters around firms that import used car tires; around firms that import lucky-bamboo plants; at other locations if: 1) the necessity of mosquito control at the location in question is evident from advice from the RIVM and the NVWA and 2) it can be demonstrated that the control strategy has been chosen with the least environmental impact." See for more information paragraph 3.2.2.

The active substances are generally available as ready-to-use products for consumers, such as dusting powders/granules, aerosol sprays or bait-boxes. For professional use, the products are either also ready-to-use or are concentrated products to be diluted with water before use.

2.4 Market data

- *Products, authorisations, and suppliers*

On the reference date (June 6th 2025), a total of 34 biocidal products with either one of the five active substances studied were authorized for the Dutch market for PT18. The authorizations for these products are in the names of a total of 10 authorization holders. Besides that, 37 products with these substances have previously been available to the Dutch market but have since either been cancelled or the authorization expired. A total of 11 authorization holders are registered in the Ctgb database for these products for the Dutch market. Some of these authorization holders are Dutch companies, while none of the suppliers of the active substances are Dutch or situated in the Netherlands.

Table 9 shows these figures further broken down.

Table 9: Numbers of products, authorization holders and suppliers of active substances

Active substance	Number of active authorised products in NL	Number of active authorisation holders in NL	Number of suppliers of active substance in EU
Cypermethrin	1	1	2
Alpha-cypermethrin	2	1	2
Deltamethrin	18	6	4
Imidacloprid	11	4	5
Lambda-cyhalothrin	2	2	1

- *Market volumes*

An attempt was made to gain insight into the amounts of the active substances and the quantities in PT18 on the Dutch market. This proved to be hardly or not possible when looking for public sources in the Netherlands, as this is not centrally registered in the Netherlands. Interviewed companies generally indicate that this is confidential company information that they do not wish to share in the context of this research. And also, available figures are usually of the formulated product and not the volumes of the active substances itself.

[33] See: https://toelatingen.ctgb.nl/nl/authorisations/24369

Yearly sales of the volumes of the five substances were obtained from several Member States where the volumes of traded active substances and biocides are annually registered. From other member states, figures appeared to be available in literature online. These volumes are together presented in table 10 below.

For Denmark the volumes of the combined sales of both plant protection products and biocides were found, but not of the sales of biocides separately. As these figures do not provide clear insight into the amounts of biocides sold in Denmark, they are not presented in this report. Furthermore, the yearly sales from Finland have also been requested, but the following answer was received: "*Finland is so small market area, that only limited number of companies sell products containing those five active substances you have listed. Eg. we have only one biocidal product containing cypermethrin and thus we cannot give you quantities traded in Finland.*" The figures from Sweden are all rounded to zero. The reported sales are low, but are not completely nihil.

Table 10: Market quantities of the five substances in a few EU countries

Active substance	Country	Kilograms of the active compound on the market for PT18							
		2017	2018	2019	2020	2021	2022	2023	2024
Cypermethrin	Belgium		654	620	460	801	925	-	-
	France						14338	17926	19964
	Croatia	468	440	560	1230	490	450	433	-
	Sweden*		0	0	0	0	0	0	-
Alpha-cypermethrin	Belgium*		-	50	0	0	0	-	-
	France						30	173	26
	Croatia	61	5052	40	50	1545	12.2	14.8	-
	Sweden*		0	0	0	-	-	-	-
Deltamethrin	Belgium		92	194	97	124	155	-	-
	France						519	471	519
	Croatia	84	7	30	24	35	5.8	1,2	-
	Sweden*		0	0	-	0	0	0	-
Imidacloprid	Belgium		8	6	18	68	408	-	-
	France						190	265	326
	Croatia	100	600	1000	80	0,8	4	1	-
	Sweden*		0	0	0	0	0	0	-
Lambda-cyhalothrin	Belgium*		0	2	6	10	7	-	-
	France						241	231	289
	Croatia*	0	60	240	230	0	0	0	-
	Sweden*		0	0	0	0	0	0	-

- = not (yet) reported.
* = reported sales are low, but are not completely nihil

Of the countries that have provided figures/have figures available, it is expected that the Belgian, Swedish and Danish market will resemble the Dutch market the most. But the Danish figures also include PPP, and it seems as if there are almost no sales of these active substances in Sweden for the use in PT18. Based on the population differences between Belgium (11.5 million) and the Netherlands (17.5 million) one might expect larger sales volumes for biocides in the Netherlands, assuming that use habits are similar for both countries (RIVM, 2023a).

There are some unexplained differences and fluctuations in the registered quantities per country between different years. E.g. the sales alpha-cypermethrin in Croatia in 2018 and 2021, compared to the other years. The same goes for imidacloprid in Croatia (strong decrease after 2019) and Belgium (408 kgs in 2022). It is unclear whether these fluctuating figures are due to administrative errors, changes in the (national or international) market, or external influences such as discussions about approval of certain substances for biocides or PPP or other reasons. It can therefore only be concluded that the available data from other EU member states are generally difficult to interpret. No quantitative conclusions for the Netherlands can be drawn based on these data.

- *Use of the five active substances in plant protection products*

The annual sales of PPP of the pyrethroids are currently publicly available up to 2023[34]. The sales data concern only the use as PPP for professional use.

[34] See:https://www.rijksoverheid.nl/documenten/publicaties/2022/05/19/afzetgegevens-gewasbeschermingsmiddelen-in-nederland

Table 11: Market quantities of the five substances for plant protection products in NL

Active substance	Kilograms of the active compound professional market for PPP in NL							
	2010	2015	2017	2019	2020	2021	2022	2023
Cypermethrin	0	0	0	0	n/a	n/a	553	460
Alpha-cypermethrin	n/a	n/a	n/a	n/a	n/a	0	n/a	n/a
Deltamethrin	2258	1782	1941	1617	1278	1344	1263	1009
Imidacloprid	10564	4899	2304	135	562	104	n/a	n/a
Lambda-cyhalothrin	2278	2374	2377	2319	1460	1228	1702	2405

n/a = no registration

Table 7 shows that cypermethrin, deltamethrin and lambda-cyhalothrin are presently authorized in plant protection products and of these, especially for deltamethrin and lambda-cyhalothrin there are several authorized products. Alpha-cypermethrin is not approved for PPP since 2001. This corresponds with the numbers in table 11. Furthermore, imidacloprid has been banned as a plant protection product in the Netherlands since 2020, with an expiry date until the end of 2021. The sales data for imidacloprid for professional use as a plant protection product have decreased from around 10.000 kg per year around 2010 to 100 kg in 2021 to no sales in the present.

- *Use in veterinary medicine in NL*

In 2023, the RIVM received and presented the ranges of the annual sales of synthetic pyrethroids that are brought to the market through veterinarians (prescriptions only). These numbers may be an underestimation, because sales from garden centres, drug stores and other shops are not included (RIVM, 2023a; Deltares 2023). Deltares received and presented the same types of data for imidacloprid.

Table 12: Market quantities of the five substances for veterinary use in NL

Active substance	Kilograms of the active compound in veterinary use in NL			
	2017	2018 and 2019	2020	2021 and 2022
Cypermethrin	0	<10	10-100	0
Alpha-cypermethrin	n/a	n/a	n/a	n/a
Deltamethrin	100-500	100-500	100-500	100-500
Imidacloprid	500-1000	500-1500	Not known	Not known
Lambda-cyhalothrin	n/a	n/a	n/a	n/a

3. Current use and alternatives

3.1 Introduction

The following paragraphs (3.2, 3.3 and 3.4) describe for the different user groups – professional users, agrarians and consumers – the use of PT18 insecticides with the five active substances. Also, from a preventative (integrated pest management) perspective, the risk awareness of the user groups is described, as well as their current options for other ways and means to prevent or control insects, arachnids and crustaceans and for the substitution of the focal substances.
Paragraph 3.3 deals with the use of insecticides based on the selected active substances in treated articles, in particular in treated textile.

The description in this chapter is based on reports, and on interviews with and written answers from those involved. In general, a reasonably consistent picture emerges from the information provided by different parties. Where sources and parties gave different or even opposite information, this is stated in the text.

3.2 Professional (and agricultural) use and alternatives

3.2.1 Professional use of insecticides with selected active substances

- *Professional and agricultural use*

Professional use in this context is understood as the application of insecticides by trained, skilled, certified professionals or by persons who are exempted by law from the competence requirements for certain applications. In this study they are represented by pest control companies and their trade associations and by trade associations of agrarians and agricultural wholesalers.

Because of their exemption from training requirements, both trained and untrained Dutch farmers have access to exactly the same insecticides (for use as a biocide) as professional pest control officers., although farmers may only use the insecticides on their own property. In this study, farmers are represented by trade associations and agricultural wholesalers.

Where this chapter refers to professional users, these agricultural users are included. Where positions or insights regarding farmers differ from those concerning professional pest control officers, this is specifically and explicitly stated.

Authorised professional use

Several insecticides based on the five selected active substances are authorised for professional use. The authorised insecticides based on these active substances are, depending on the authorisation, intended for indoor and/or outdoor use, and aimed at different target organisms.

- There is a single biocide containing cypermethrin authorised for professional use, although this is a very recent development (authorized on May 7th 2025). This product is a powder that can be applied indoors to combat German and oriental cockroaches, black garden ants, crawling insects, and wasp nests.
- Two products based on alpha-cypermethrin are authorised for professional use, with a limited area of application: only in poultry housing, against German cockroaches, black garden ants, house and stable flies, mosquitoes and wasps.
- A number of products containing lambda-cyhalothrin are authorised for use by professionals. These products in granule and powder form are for use against black garden ants, and are to be applied by sprinkling as a powder or pouring after dissolving. These authorisations are for use both indoors (only at locations that are not wet cleaned) and outdoors (only on paved surfaces). The products that are on the market as concentrates are intended for indoor control of house and stable flies in animal housing (dairy cattle, beef cattle, pigs, poultry).
- There is a wide range of authorised products for professional use containing deltamethrin and imidacloprid. Deltamethrin products are either sprayed, sprinkled, dusted or soaked for the control of a wide variety of

insects, arachnids and crustaceans. They can be used both indoors and outdoors, around buildings and houses (terraces, patios, paths).
- Products based on imidacloprid mainly concern ant bait boxes or gel bait from a syringe or tubes in combination with a gel bait applicator. These are used to combat various species of ants and cockroaches. Two approvals are for the control of flies, where the diluted product is applied to cardboard sheets and hung at the location where flies are to be controlled. Products for controlling ants can be used both indoors and outdoors, while control of the cockroaches and flies with these products is only authorised indoors.

- *Wholesale supply for professional use*

Professionals usually buy insecticides from specialized wholesalers. In addition to a few larger suppliers, there are several smaller suppliers active (usually web shops), who, in addition to biocides, have a wide range of alternative chemical and non-chemical pesticides, equipment and articles used for pest prevention, personal protective equipment, and other products related to pest control.

Agrarians often buy their biocides from the same suppliers where they buy plant protection products. Next to a few larger suppliers, there are several smaller wholesalers active in this market.
Additionally, companies that sell agricultural supplies (other than plant protection products) are also allowed to sell biocides. This sale is less restricted than with plant protection products, where the selling party is also subject to a license (which is not the case for sale of biocides).

Little is known about the sales of biocides to professional and agricultural users in the Netherlands. Unlike in Belgium, for example, there is no national registration. Various interviewed wholesalers indicate that the sales of biocides (both rodenticides and insecticides) have decreased sharply in recent years. A wholesaler who also sells in other European countries also indicates that their sales of insecticides in Belgium are up to a factor of 10 higher than in the Netherlands. These statements are, however, not substantiated with actual figures.

Professional pest control officers in the Netherlands indicate that they consciously focus more on preventive measures. In addition, they say that they more often choose less risky substances and alternative non-chemical control methods. These alternative means and methods are mentioned by both professional users and wholesalers, who see a shift in sales to other (less harmful) means and methods, like non-chemical products or preventative measures. These statements are also not substantiated with actual figures.

3.2.2 Risks associated with professional use of these insecticides (PFAS)

- *Associated risks of professional use*

The respondents in the category of professional users (pest control officers, agrarians and wholesalers) seem to be broadly aware of the dangers that these five active substances pose to humans and the environment. When asked about these, the risks to non-target organisms are particularly mentioned here, and to a lesser extent the risks to water quality. The latter in particular is broadly seen as a risk that exists due to agricultural use of plant protection products.
One professional respondent has a different opinion. According to him, plant protection use is a large contributing factor of water pollution for the five active substances, but biocidal and veterinary medicine use cannot be neglected. The treatment of large structures against woodboring beetles requires large amounts of biocides (this is through biocidal application in PT08), which could leak into the soil, also for instance after application in crawl spaces (application in PT18). Active substances can easily seep into the ground and reach groundwater. Knowledge of the building and for instance the type of soil on which it is built are important to allow anticipation and prevention of these risks, according to this respondent.

Most professional users are of the opinion that environmental risks caused by application of biocides by their own profession are very limited. Reasons given are:
- Trained, skilled professionals know the risks associated with biocides and their active substances, are aware of these risks, and act accordingly.
- Insecticides (and empty containers) are applied and disposed of according to the regulations in the SPC. This includes dosage, methodology, precautions and disposal of residues and packaging.
- Insecticides based on these five active substances are mainly used indoors. Leaching into the environment is not really considered a risk with indoor use.

Mitigating factors that are mentioned are:

- The quantities of insecticides used outside buildings are usually very small and localized. Exposure of non-target organisms and dispersion in the environment are therefore limited.
- Synthetic pyrethroids usually have an effect duration of 6 to 8 weeks according to the manufacturer. Before applied insecticides are washed out via groundwater to surface water, their effectiveness is greatly reduced. This is, of course, assuming clients are informed by the professional about this risk and are requested to not wet-clean treated surfaces. Additionally, chemical decay of active substances might slow down within soil or sludge, leading to prolonged effects of these chemicals within the environment.

Professional users see more risks in the application of insecticides by consumers and agrarians than in the insecticide use by the professional pest control industry. They see consumers as a major risk factor, due to their lack of education and information. There is also the idea that risks arise due to the average consumer not (properly) reading or following the instructions for use and safety as described on product labels. Consumer use is discussed further in paragraph 3.3.

The agricultural users that have a license to use plant protection products[35] are informed – up to a certain extent - about the risks of active substances for humans and the environment within the training related to this license. This information includes the risks for ground and surface water and the various emission routes. Agrarians that do not apply plant protection products do not need to be trained on insecticide use (but may still apply insecticides as biocides) and may therefore be less aware of environmental risks and exposure routes. Since the distance between the places where insecticides as biocides are used by an agrarian on the one hand, and nature or surface water on the other, is shorter than that of consumer use, respondents state that the risks of agricultural application of biocides may be relatively higher than those of consumer use.
It is not known if (and how) agrarians who do not use plant protection products and therefore do not have the plant protection license, are aware of these risks. Suppliers do provide product safety sheets with their products, but do not actively implement an information policy to inform this group of agrarians about the risks for humans and the environment.

The exposure routes to groundwater and surface water when applying insecticides containing the five selected active substances are mainly seen and considered important by professional users where these products are used outside. Here, contact by other non-target organisms with the applied insecticides cannot always be avoided. Target organisms that are allowed to be chemically controlled outdoors with these products are wasps and ants.
Leaching into groundwater or surface water is less perceived as a risk by professional users. The quantities applied outdoors by professionals are, in their own opinion, very limited. In addition, the speed of degradation of synthetic pyrethroids is mentioned as a reason why leaching into groundwater and surface water can only occur to a very limited extent.

Agricultural application of insecticides containing the five investigated active substances is often aimed at controlling flies in stables. Since entire walls and often roofs are sprayed (as mentioned by a agricultural wholesaler), it cannot be prevented that mist settles on the floor and ends up in manure. The active substances can also end up in the manure through rinsing of the walls. Additionally, active substances from veterinary medicine can also end up in manure. When the manure is then spread, the active substances can spread via groundwater (leaching or runoff) to surface water. The emission route from the plot – via groundwater – to the surface water through leaching will take longer (with a greater chance of degradation) than directly from the plot to the surface water through runoff.

It is unclear how this relates to the insecticide use in plant protection and to what level the effectiveness of active substances diminishes before leaching this way. The National Institute for Public Health and the Environment (RIVM) researched routes via which active substances could end up in manure, and generated a list of 37 active substances that have the potential to be found in manure and soil in the Netherlands (RIVM, 2025a). Of the five active substances researched in this report, alpha-cypermethrin and lambda-cyhalothrin are included in this list. Since deltamethrin and imidacloprid are not considered relevant because no products are permitted in the Netherlands with applications for which emissions to manure are relevant, RIVM excluded them from their list.

[35] This license to use plant protection products ('spuitlicentie' in Dutch) is the required license of competence for any professional working with plant protection products in the Netherlands.

Another route from professional use to surface water that is mentioned in interviews is flushing via the sewer. This can happen when insecticides are applied (indoors) to paved surfaces. When these surfaces are then wet cleaned, active substances can end up in the surface water via the sewage system. It can be argued that insecticides are rarely applied to very large surfaces, more commonly insecticides are applied in cracks and crevices. With this application, flushing active substances as a result of cleaning is less likely. Most SPCs also state that the treated area may not be for a certain amount of time after treatment.
Active substances can also end up in sewers when spraying equipment (e.g. hand sprayer) of the professional pest control officer is rinsed out and the rinsing water is not collected separately and disposed of as chemical waste, but is flushed away via the drain. Professional pest controllers consider this risk less likely, since they are trained with the instruction that the required amount of insecticide is calculated and mixed per control treatment. This means that barely any residue should remain, and respondents state that residues are collected and disposed of as chemical waste.

One noteworthy route into ground- and surface water is the national protocol for the eradication of exotic *Aedes*-mosquitoes. The Netherlands Food and Consumer Product Safety Authority (Nederlandse Voedsel- en Warenautoriteit, NVWA) oversees monitoring and control of these mosquitoes. Although the main focus of their protocols regards removal of breeding ground and the use of biocides based on the bacterium *Bacillus thuringiensis*, on certain priority locations (importers of 'Lucky bamboo' and second hand tires) a nebulization treatment with a product containing deltamethrin is allowed and conducted[36]. A significant area is treated with a fine mist containing deltamethrin, which can be carried at least 30 meters at low wind conditions. These treatments are therefore conducted only at low wind speeds. Only professional Pest Control Officers (PCOs) with additional training for carrying out this treatment according to protocol are allowed to perform this task. One of the tasks of these PCOs is to determine the locations that can or cannot be treated without contaminating surrounding surface waters.
To the question whether other products or active substances can replace the current product, the NVWA states that there are no other, less harmful, authorized products in the Netherlands to combat adult mosquitoes at this moment. Because of the limited use of this product (only by bamboo and tire importers), authorization of an alternative is not expected soon, due to the time and costs of the authorisation procedure. In 2020 the NVWA performed an extensive evaluation of possible alternative authorized products (including alpha-cypermethrin, etofenprox, metofluthrin, permethrin, and transfluthrin), but none of these proved to be acceptable alternatives.

One responding NGO is very clear in its response about the environmental hazards of the 5 selected active substances. According to this NGO, they should be banned. The NGO did state, however, that emission risks from the use of biocides, for example through spreading manure, cannot be ruled out, but that environmental risks of applying plant protection products are many times larger.
This view is supported by professional users and respondents from the biocide trade. The problem is that no figures of sales, use and routes to surface water are available. Several respondents suggest that measurements at sewage treatment plants could possibly provide more insight into the presence of these active substances in water. It should be noted that this still would not differentiate between biocidal, plant protection, or veterinary drug use.

An option suggested by one of the pesticide wholesalers (for both agricultural and pest control) is to potentially add chemicals markers to active substances, provided that these markers are distinctive, easy to detect, harmless to humans, animals and the environment, and do not interfere with the effectiveness of the active ingredient. By making a distinction in the markers between, for example, plant protection products, biocides and veterinary medicines, it could be possible to trace the origin of measured active substances in surface water. According to this respondent, it might even make a distinction possible between insecticides originating from private use those from professional use. However, the feasibility and potential side effects of implementing these kinds of markers are unknown.

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[36] In the years 2020-2024 a total of 89 treatments with this product were performed. The total amount of product used amounts to 114.175 mL, containing 2,5% deltamethrin.

- *Professionals' risk awareness*

It was briefly indicated above that the professionals state that they are aware of the dangers and risks of biocides based on the selected active substances. In the interviews with the professionals it was indicated that during the pest control training[37] and also within the companies, attention is paid to how one should handle insecticides and what risks these products pose.
Subjects covered within the training include:

- Knowledge of active substances;
- Impact on the environment of biocides;
- Working according to the instructions on a product label or SPC;
- Preparation of biocide products (correct dosage and concentration);
- Application techniques;
- Instruction of clients regarding biocide products, usage, and risks;
- Use of personal protective equipment;
- Disposal of empty containers and residues.

Similar topics are – up to a certain level - addressed in the training of agrarians for the license of professional competence to apply plant protection products (spuitlicentie). As mentioned earlier, particularly agrarians without such a license who can still apply insecticides, are dependent on other information channels to be informed about risks of these products and the active substances within. Wholesalers and agricultural trade associations could play a role in this. One of the wholesalers states that it has made the conscious decision not to supply biocides to agrarians without a plant protection license. Another wholesaler reports that it relies on product safety sheets and the instructions on the label. The agrarian is expected to follow these guidelines and use biocides in a safe manner.
One of the agricultural trade associations has indicated that they offer their members (online) a decision tree and points of attention per product group on the basis of which they can make a good choice for biocides.

In addition, there is an increasing focus on preventive measures and the use of (or combination with) alternative (non-chemical) control methods by professional pest control officers. Integrated Pest Management (IPM) is clearly named by professionals in this context as a standard within which the use of chemical pesticides is seen as a last option within a management plan. IPM and alternatives are discussed in more detail below.

- *Risks for professionals*

Professionals can be exposed to insecticides at different moments and in different ways. The most common exposure route is through skin contact, but biocides can also enter the body through ingestion or inhalation.

Risks of exposure are usually not highest at the moment of application, but in actions before or after the treatment. This includes handling packaging, transferring powders or liquids to application equipment or contact with contaminated clothing or personal protective equipment after the biocide treatment.

In general, PCOs state that the risks for professional users are negligible when they work according to the regulations and instructions on product labels. PCOs, agrarians, and distributors indicate that the use of insecticides by professionals has decreased. Some respondents mention a large reduction, others see a slow decrease. Biocide application is not a daily activity and the quantities of insecticides per situation have also decreased, since application is more targeted on problematic situations instead of a preventative treatment of a whole building. Biocide use is often combined with alternative measures and/or resources, and often in such a proportion that the use of insecticides is experienced as a supportive measure that accompanies non-chemical methods instead of the other way around.

There are no known figures on exposure to insecticides within the professional group of pest controllers in the Netherlands. However, there are anecdotal stories known of professionals who have developed a hypersensitivity over many years, particularly to synthetic pyrethroids. This usually manifests itself in itching skin upon exposure to the agent.

[37] This is the Dutch training: Opleiding t.b.v. Bewijs van vakbekwaamheid biociden – Rgb Art. 6; https://wetten.overheid.nl/jci1.3:c:BWBR0022545&hoofdstuk=6&paragraaf=1&artikel=6.4&z=2024-04-20&g=2024-04-20

- *Risks for clients*

Risks for clients (both businesses and consumers) are detailed in 3.3.2 (Risks associated with consumer use of these insecticides).

The risks for a client can be minimised by the professional through a careful decision of the moment of preparation and application, as well as skilled use of (a minimum of) biocides. Even when the client is not present in the same environment when a pest control treatment is carried out, the risk of client skin contact to treated surfaces after the pest control treatment has ended remains. However, as stated before, this is not the case when cracks and crevices are treated, which is a more common method in households than surface treatment.

- *Professionals view on consumer use*

Opinions differ on the extent to which consumers should have access to insecticides. On the one hand, it is believed that the safety of consumers is not served by them using insecticides injudiciously themselves. Risks with regard to the environment are also estimated to be higher in this case compared to use by professionals who have had explicit training regarding biocides, their risks, and safe use. However, an increase in use of illegal products is expected if a complete ban on consumer insecticides is enforced, which could potentially entail greater health and environmental risks with a decrease in insight into actual biocide use in the Netherlands. Reference is also made to the purchases of rodenticides abroad, since the reduction in supply for consumers in the Netherlands. Another risk is that home care products such as chlorine, salt and vinegar would be used (for instance by pouring these in ant colonies) that have no effect but do damage the environment.

Another disadvantage of limiting the supply of insecticides for consumers, which is mentioned by both pest controllers and wholesalers, is the income stream to producers. The margin on consumer products is many times higher than that for the professional market. If income from consumer products is lacking, there is less money available for the development of, for example, alternative (less harmful) active substances and the registration for their approval in the Netherlands. Some professionals fear that this would lead to a decrease of the supply for professional users and that development of alternatives will be slowed down or neglected. In the past, innovation in biocide was often a result of innovation within the plant production products. This larger market had access to larger research and development budgets, while biocides 'hitchhiked' along with the development of new insecticide products.
A reduction in innovation and stricter regulations would result in the variety of products becoming smaller, which might lead to a stronger reliance on the few available active substances, increasing their use and the chance of resistance development in pest species.
There are also parties that state that some producers and retailers focus solely on professional or consumer products, so a ban on consumer products should not be of any effect on the available options for professionals.

3.2.3 Alternatives for professional use of these insecticides

To what extent are these products essential for pest control by professionals and what alternatives are available? Below, we look into possible chemical and non-chemical alternatives and into several options to reduce professional use.

- *Alternative insecticides/ active substances*

The range of insecticides used by professional users consists mainly of biocides based on deltamethrin and imidacloprid in various formulations and concentrations. The range of insecticides based on other active substances than these five is limited and often more expensive.

Lambda-cyhalothrin is only available as an insecticide for professionals in agricultural environments (livestock farming) to combat flies. Interviewees are not aware of this active ingredient being a PFAS. As far as its use as an active ingredient in biocides, there are alternatives available that can be used if lambda-cyhalothrin is no longer available.

The impacts of a ban of the five selected active substances are diverse, according to respondents, both professional users and wholesalers. The greatest risks mentioned are in the area of public and animal health and food safety. Even when using preventive measures and alternative pesticides or non-chemical methods, a common opinion is that insect control using insecticides should remain available as an option for professional pest control officers. If insecticides based on the five active substances were to be discontinued, professionals would be limited in their choice of agents. Resistance management prescribes that active substances must be alternated to counteract reduced sensitivity to specific active substances. When this choice is reduced, resistance can more easily occur. This is even more the case when the available options are all pyrethroid active substances, as resistance against these substances overlap.

Additionally, alternatives (like heat treatment, biological control agents, or a controlled atmosphere with reduced oxygen levels) are not in all situations applicable, practical, or replace the pest species with a biological control agent which can be unacceptable for clients.

Reasons given for continuing to have insecticides available include food safety (for instance in food production and storage facilities) and public health (mosquitoes). Interviewees state that in these cases a quick and effective control measure is required, which is assumed to not be feasible when relying solely on non-chemical treatments. They agree that the focus should be on preventative measures and monitoring, but swift actions should be taken when problems arise.

In the agricultural sector problems may also arise if insecticides based on the selected active substances are no longer permitted. While biological control and preventative measures can be effective, having a biocide available as a last resort is required to control for instance these species:

- Flies cause nuisance in the surrounding area and can transmit diseases.
- Red mite causes problems for poultry and can transmit diseases.
- Lesser mealworm / Litter beetle causes damage to stables and can transmit diseases between poultry.

The approval of insecticides and larval control products based on other active substances is also under pressure. According to one of the agricultural sector organisations, the loss of various active substances and biocidal products makes the control of fly populations in particular very difficult to impossible and increases the chance of resistance.

- *IPM and alternative (non-chemical) means to prevent or control*

All professional pest controllers that were contacted are aware of Integrated Pest Management (IPM) and see it as the basis of insect control. Within IPM, 4 steps are of importance: Monitoring, Prevention, Non-chemical control, Chemical control.

The agricultural user who wants to use rodenticides on his own terrain must follow a short training in which the principles of IPM are explained. In this group too, awareness of the importance of Integrated Pest Management will be present.

Monitoring is a basis, where both the presence of pests is investigated as well as potential risks for future development of pest problems. Preventative measures should be taken if risks are discovered to prevent this development. Non-chemical control is the preferred method of control of pests, and only if this gives insufficient result (or is not feasible in this scenario) chemical control is available as a last resort.

- Monitoring

Monitoring can be performed by visual checks for presence or absence, supported by tools that attract and capture insects. Examples include:

- Fly lamps. Non-selective attraction of flying insects by means of UV light, where flying insects are captured using glue plates or an electrocution grid.
- Using pheromones (PT19), traps can be placed to selectively attract males of specific target organisms. Capture takes place using glue plates or catch cups.

- Preventive measures

Prevention is the basis for preventing or limiting pest nuisance. In most cases it is essential that the professional and client work together to achieve the best prevention. Preventative measures focus both on reduction (or complete halting) of immigration of pest species, as well as the removal or making inaccessible of food sources. The professional should make an inventory of the points of attention regarding pests, after which options to reduce or exclude these risks should be discussed with the client. This includes for instance methods of introduction of pest animals, available food sources, hiding spots. When preventive conditions are optimal, risks of pests are minimized and control is often not necessary or at least less intensive or frequent.

A preventive measure that specifically applies to agrarians is the handling of manure. The development of flies in manure can be fast (depending on the temperature), 2 to 3 days. By removing manure frequently, the nuisance of flies should remain small. If fly nuisance does occur, removing the manure can be a part of the pest management plan of at least one responding pest control company that has mainly farms as clients.

- Non-chemical treatment

For the non-chemical control of insects a professional has various basic techniques at his disposal, although it should be noted that these cannot always be used in all circumstances and for all insect species.

- Mechanical control
  Mechanical control can be done by means of equipment or products that have a physical mode of action:
  - Paraffin oil
    A very specific form of control in which stagnant water - usually in crawl spaces or slurry pit - is covered with a layer of paraffin oil. This stops the development of mosquito larvae, for example, by hampering their contact with the air, preventing them from breathing.
  - Provecta
    A liquid treatment against insects, which makes the insects immobile by molecular encapsulation. The disadvantage of this form of control is that the product only works as long as insects come into contact with it when the product is still wet. As soon as the product has dried, it loses its effect.
  - Diatomaceous earth / kieselguhr
    Diatomaceous earth has a sharp structure and damages the chitin shield of insects that come in contact with the product, causing them to dehydrate. When wet, this product loses its effectiveness, it is unclear how long this alternative remains active in dry conditions. Additionally, the potential effects (and occurrence) of leaching into ground- or surface water are unknown.
    In the case of indoor applications, sufficient precautions must be taken in connection with possible irritation of the skin, eyes and respiratory tract of people and pets.
  - Other mechanical control methods are for instance vacuuming, fly lamps, glue traps (with or without attractants), the displacement of wasp nest, and insect swatters. In the case of a one-time presence or a limited infestation, such means can provide an adequate result. However, these mechanical solutions for insect nuisance are usually inadequate for larger numbers of insects, especially when the cause is not removed.

- Climate control
  - Reduced oxygen treatment
    When expelling oxygen from an environment (by introducing CO_2 or N_2), all life stages of insects are killed. Application is often in batches on (lots of) goods by using conditioned spaces. If the space to be treated is limited in size, contaminated spaces can also be treated in this way.
  - Heat treatment / Cold treatment
    By heating (>55°C) or freezing (<-18°C), all life stages of insects are killed. The same limitation as with reduced oxygen treatment apply to these methods. However, heat treatment of smaller spaces (for example hotel rooms against bedbugs) is possible. An alternative form of heat treatment is treating ant nests with hot water.
  - Humidity
    Reducing humidity can affect the survival of insects, however susceptibility differs between insect species.
  - Irradiation
    Food and goods that are sensitive to other non-chemical control methods can be treated against the presence of insects and micro-organisms by means of low dose of gamma radiation.

- Biological control
  Biological control can be achieved by using predators or parasites (including nematodes, parasitoid wasps, predatory mites, birds, bats) or bacteria and fungi to kill insects. In some cases these biological control agents are applied directly (for instance parasitoid wasps), while in other cases the presence of naturally occurring agents is promoted (for instance by placing bird or bat houses). These methods are well suited for plant protection and to control flies in stables and manure. This method of pest control is slowly becoming

more popular in livestock farming. However, experience shows that in addition to the use of biological control, sometimes the use of insecticides remains necessary when the level of biological control is insufficient.
This form of control is usually not suitable for controlling indoor pests in private homes and especially not in food companies. In this case complete removal of the pests is desired, adding other animals will not be acceptable for a client.

- Chemical control

Within the IPM approach, biocides are the last option to combat pest nuisance, the last resort when all other options are insufficient or cannot be applied. In practice it is seen that when biocides are applied, this is often in combination with non-chemical control methods to limit the use of biocides and to make the total treatment as optimal as possible.
Another consideration made before the step to chemical control is taken is whether the application of insecticide will have the desired effect. When the circumstances have not changed (e.g. food sources remain available) or when the applied agent becomes inaccessible to the target organism due to dust formation, the choice is often made not to use chemical control since application would be futile.

- Considerations when applying alternative control methods

In general, it can be said that most professionals and agrarians are not averse to the available non-chemical control methods. The most important factor that affects the choice of control method is the expected effectiveness, as do costs and the speed at which results can be expected. Many clients want results quickly, at the lowest possible cost. This can hinder the consideration of alternative control methods.

- *Options to reduce professional use*

IPM is widely seen as the best method to consciously limit the use of insecticides. IPM is also seen as the most sustainable solution, since recurrence of nuisance is less likely as a result of preventive measures. A parallel with the use of rodenticides is often drawn by the interviewees. Professional users would like to see that they have access to the widest possible range of resources, but most agree it might be best to have this confined within an IPM protocol. In this regard, consideration could be given to making this a certified condition, similar to the IPM Rodent Control.

3.3 Consumer use and alternatives

3.3.1 Consumer use of insecticides with selected active substances

Authorised consumer use
As was described in the previous chapter, insecticides based on all five selected active substances are authorised for use by non-professionals i.e. consumers. They concern both inside and outside uses with different application methods and different target organisms.

- One cypermethrin based product is authorised for consumer use: a dusting powder for use against crawling insects in seams, cracks and cavities, as well as for direct application in ants and wasps nests.
- Two alpha-cypermethrin based product are authorised for consumers (hobby famers), with a narrow application area: inside poultry housing for one biocidal product and in animal housing of cattle, pigs and poultry for the other, to be used against cockroaches, black garden ants, flies and wasps.
- Only one lambda-cyhalothrin based products is currently authorised for use by consumers: granules against road ants, to be applied by sprinkling. They are for use both inside (but only at places that are not living spaces and that are not wet-cleaned) and outside (only on paved grounds).
- There is a broad array of authorised deltamethrin- and imidacloprid based products for use by consumers. Deltamethrin-based products are either sprayed, sprinkled, dusted or used for soaking (with a watering can) for control of a large variety of insects, arachnids and crustaceans. They can be used both inside and outside, around buildings and houses (terraces, patios, paths).
- Imidacloprid based products mostly concern ant bait boxes or gel bait from a syringe, or tubes in combination with a gel bait applicator. They are all used to control ants (several different species), next to one product against cockroaches. These products too can be used inside and outside, around buildings and houses (but not on soil, lawns or flower beds).

– Besides biocidal use, these active substances are also available for the consumer-market as veterinary medicines and plant protection products. See also table 7.

According to several producers, particularly imidacloprid and lambda-cyhalothrin based biocidal products are mainly sold to the consumer market. One producer has authorisations for lambda-cyhalothrin based products for consumer use and for professional use in the Netherlands. However, this producer only markets the consumer products; the authorisations for professional products are not used. One other producer does (only) market a lambda-cyhalothrin based product for the professional market. On the other hand, according to one interviewee, 80% of the deltamethrin turnover in the Netherlands concerns products for the professional market. The same is said to hold true for alfa-cypermethrin.

Retail supply for consumer use
Generally speaking, the main retail channels through which consumers buy insecticides are physical drugstores, garden centres, DIY and pet shops (RIVM, 2019a and 2020; information of retail sector organisations). Most of these stores also have different chemical (low-risk and non-low-risk) and non-chemical control options on offer (like fly swatters (manual, electric), fruit fly traps, glue-based products (fly traps), products with pheromones, UV lamps).

Some sector organisations (Tuinbranche Nederland, Vereniging van Winkelketens in de Doe-het-Zelf branche VWDHZ), together with suppliers and retail organisations, signed an ambition document (2020-2024) to contribute to consumers' responsible use of pesticides (Tuinbranche Nederland, 2020). Elements of this ambition are to actively inform and stimulate consumers to take preventive measures, use low-risk and ready-to-use products and to discourage the use of non-authorised home remedies. Although the focus of these ambitions was on plant protection products, it is expected that they also affect the sales and use of biocides including insecticides.
It is not clear what the effectiveness of the efforts has been. Retail stores were free to deal with the ambitions in their own way. Also, many of the consumers in these stores do not seek advice from personnel before picking products from the shelves. And: on these shelves, insecticides with the active substances under study remained present.[38] For almost[39] all retail organisations[40] the basic principle is: 'if a product is authorised by Ctgb, we (can) sell it'.

Recently, sector organisations of drugstores, garden centres, DIY and pet shops provided the independent website for consumer information on sustainability 'Milieu Centraal' with information on insecticides.

In more recent years (from 2015 onwards), a shift has been noted in retail channels through which consumers buy pesticides (again, with the focus of the research on plant protection products), towards chain stores (household shops and discounters). RIVM (2020) reports that before 2015 sales through chain stores was negligible; however, in 2017 34% of all sales went via chain stores. and 15% of all sales in 2019. This mostly concerns batch sales.

In the period of their research (2014-2019), RIVM (2020) reports that only a small fraction of pesticide sales takes place via internet. There are no indications that this has changed much in recent years. Still, several interviewees point at specific ways and channels through which consumers can easily get hold of insecticides that may or may not be authorised for their use (e.g.: products for the professional market) or that are very cheap, accessible and uncontrolled (and illegal) (e.g.: through online stores from outside the EU).

Insecticide use by consumers
- Consumer use

Research carried out on behalf of Milieu Centraal in 2019 and 2022 among more than 1000 consumers (18+) (GfK 2019, 2022) provides a reliable image of consumers' use of insecticides. The table below presents some of the data from this research.

[38] Only glyphosate was phased out.
[39] Exceptions are some 'green', biological garden centres.
[40] The sector organisation of drugstores claims that in the drugstores it consulted no insecticides are sold based on the five selected active substances. However, it is not clear what this claim is based on and why this would be so (based on which principle).

Table 13: Consumers, pests and pesticides (source: GfK 2019, 2022)

	2022		2019	
Have you had to deal with small pests in the past year?	39% yes	↓	41 % yes	↓
Which pests did you suffer from in/around your home?				
– Ants		45%		34%
– Slugs		32%		27%
– Mosquitoes		28%		26%
– Silver/paperfish		27%		28%
– Fruit flies		26%		28%
What have you done against pests in/around your home in the past year?	(Of 39%)	↓	(Of 41%)	↓
– (Chemical) pesticides		38%		42%
– Home remedies		34%		36%
– Manual removal		34%		27%
– Food kept out of reach (of pests)		23%		22%
– Sealing holes and chinks		22%		18%
– …				
– Called in professional help		6%		7%

Approximately 40% of the people who say they have had to deal with small pests (around 40% of the population) use (chemical) pesticides. Which means that roughly speaking 15% of Dutch people ages 18 and up have used pesticides against small pests. Given the prevalence of ants, mosquitos, silver/paperfish and fruit flies among these small pests, a large part of these pesticides can be expected to be PT18 insecticides.

What considerations do consumers have when choosing a method of pest control? In the two studies carried out on behalf of Milieu Centraal in 2019 and 2022 (GfK 2019, 2022), this question was asked in different ways.

- In 2022 respondents were asked to rate the importance of several considerations
- In 2019, they were asked to indicate which two considerations matter most to them.

As both types of questions are quite insightful, the answers to both are presented in the table below.

Table 14: Consumers consideration when choosing a method of pest control (source: GfK 2019, 2022)

	2022	2019		
– 2022: How important do you consider these aspects when choosing a pest control measure? – 2019: What do you consider most important and second most important when choosing a measure to control pests in and/or around your home?	% very important or important	% most important	% second most important	Total
Effectiveness	90%	51%	19%	70%
Safety	87%	16%	22%	38%
Environmental friendliness	81%	13%	19%	32%
Convenience/user-friendliness	75%	6%	18%	24%
Animal friendliness	69%	9%	12%	21%
Price (cheap)	52%	4%	10%	14%

The table clearly shows that consumers state that effectiveness most of all guides their choice of method. This is confirmed by the sector organisation of Dutch garden centers.

Very little is known about the extent to which consumers call in the help of professional pest controllers (other than what is reported in table 13, which suggests that this is done by approx. 2% of the respondents). According to some professional pest controllers, the costs of calling in their help plays a very important and often impeding role.

- Amount of insecticides used by consumers

Only very general estimates are available about the tonnage of pesticides consumer use amounts to in the Netherlands. Often these estimates do not distinguish between plant protection products and biocides. One exception can be found in an RIVM report (2019). Between 2014 and 2017 sales of insecticides to consumers are reported between 600.000 and 800.000 unit sales (making up for about half of all biocides sales to consumers). More than half of the insecticides are for use against ants (see also CLM, 2022), one third against flying insects and one sixth against (other) crawling insects.

For Belgium, specific numbers are mentioned in an advice by the Belgian Hoge Gezondheidsraad (2015) ('High health council'): in 2013 800 tonnes of products were bought by consumers, containing 75 tonnes of active substances. According to some interviewees, Belgian consumers generally use more insecticides that Dutch. However, reported amounts in Belgium are hard to compare with the amounts reported in the Netherlands, not just because the Belgian data are in tonnes and the Dutch in unit sales (see above), but also because a detailed insight into the background of the data is required for an accurate comparison (RIVM, 2023, appendix B14.3).

There are mixed signals about possible changes in pesticide use by consumers. Several interviewees report that they experience a growing reluctance among consumers to use chemical pesticides in general (and of neonicotinoids and PFAS in particular). Concerns about and a growing aversion to bringing chemicals into the environment, as well as public reports of declining bee and insect populations, would be part of the reason for this. Other interviewees note no clear changes over the years in the amounts of chemical pesticides used by consumers (other than fluctuations between years with more or less pest nuisance).

3.3.2 Risks associated with consumer use of these insecticides

Associated risks of consumer use
Many respondents believe that the use of PT18 insecticides with the selected active substances by consumers poses more risks (to the environment, and also to themselves) than the use of the same products by professional pest controllers and agrarians. The main reasons for this are thought to be:

- that consumers are unaware (or at least not fully aware) and uninformed of the risks (see below for a further discussion of this);
- that they are uneducated about the proper use of these insecticides and do not always read (and follow) use instructions with proper care (see also below);
- and that they tend to use too high doses to be on the 'safe' side (meaning: to obtain fast and effective pest control).

Mitigating factors that are mentioned are:

- that concentrations of active substances in consumer products are generally lower than in products for professional use;
- that consumer use of these pesticides mostly (but certainly not always) takes place inside;
- and that use in ant bait boxes (gel bait stations) prevents overdosing and largely inhibits exposure of humans and non-target organisms. (Also, the gel contains a bitter tasting substance).

An aggravating factor that is mentioned is that outside consumer use is mostly on paved surfaces, and therefore insecticides wash off faster.

According to some sources, these 'relative' higher risks lead to more than negligible risks for consumers themselves. This is described later in this section. As to environmental risks, the question is along which route exposure of non-target organisms and environmental exposure to these pesticides, particularly to surface waters, can take place.

The following routes are deemed to lead to environmental and non-target organism exposure:

- Granules, (dissolved) powders, gels (particularly with lambda-cyhalothrin, deltamethrin or imidacloprid):
  - that are used outside of the house and that wash away, either into the sewer or into open surface waters.
  - that are used inside at places that are wet-cleaned at some point after the application, with the cleaning water entering the sewer.
  - that are taken into insects nests and that enter the soil from there.
- Alpha-cypermethrin based products used by hobby farmers in animal housing that is washed away (possibly also via manure).

– (Or, possibly, washing out insecticide-treated textiles; see the next paragraph). (Also: insecticide-exposed textiles / work clothes).

It is not clear to which extent exposure via these routes actually gives rise to more than negligible risks for the environment and non-target organisms. As to its contribution to surface water pollution: this issue is further addressed in chapter 4 of this report.

Consumers' risk awareness
As noted above, many (not all) respondents believe (to the level of conventional wisdom) that most consumers lack risk awareness when it comes to insecticides. According to these respondents, consumers expect insecticides to be safe simply because they are freely available in shops.

Given the results of the Milieu Centraal survey cited earlier (GfK 2019, 2022), some nuance here seems appropriate. Respondents were presented several methods of pest control and were asked how they rate the environmental harm of these methods. The table below shows their answers for the methods they rated most harmful.

Table 15: Consumers' rating of environmental harm of methods of pest control (source: GfK 2019, 2022)

	% (Very) harmful for the environment	
	2022	**2019**
Pesticides	59%	64%
Home remedies	14%	(-)*
Professional help	14%	19%
Traps / cages	8%	9%
Chasing away	7%	10%

* Option not presented in 2019

From these data the image arises that consumers are not necessarily unaware of the possible harm – in general[41] – of using chemical pesticides. Effective solutions matter most to them, however, particularly where small pests are concerned.[42] Probably, in combination with the believe that what is openly for sale in trusted shops must be safe, this leads them to choose in many cases for the use of chemical insecticides.

Besides, it is interesting to note that more than 4 out of 5 consumers report that they stick to the instructions for use, and that almost 3 out of 4 report that they take into consideration whether or not it is raining or rain is expected when applying pesticides again small pests (GfK 2019, 2022).

Risks for consumers and households
Consumers and households can be exposed to insecticides in several ways. They can be exposed dermally, orally or by inhalation, either by applying insecticides themselves or by being in a room or touching an object that is/was treated against pests. They may even be exposed to a certain 'background concentration' of active substances.

- Background concentrations

The latter situation appears to be demonstrated by a research project carried out by Velt (2024). In this project dust from bedrooms in 112 households (mostly in Belgium, some in the Netherlands) was analysed for the presence of active substances of pesticides. These households were of variable composition and localisation, and most of all: they had not used pesticides in the garden or against pests in the last year, nor did they have plants in their bedrooms. Reportedly, overall, in all bedrooms 137 active substances were found, in varying concentrations. The table below describes the number of bedrooms and the concentrations in which the active substances were found that our focal to our study.

[41] Consumers are unlikely to be aware of the water-harmfulness of these products or that one of them is a PFAS.
[42] One interesting finding of the Milieu Centraal-surveys is that consumers report they are bothered by green mould on garden tiles (algae and moss) just as much as by small pests (64% has to deal with it; 19% is seriously bothered). However, only 18% of them say they use pesticides to control green mould, more than half say they remove it manually.

Table 16: Number of bedrooms and concentrations in which active substances were found (source: Velt, 2024)

	Number of bedrooms	Highest concentration (mg/kg)
Cypermethrin (16th highest position out of 137 for no. of bedrooms)	37	0,520
Imidacloprid (7th highest position out of 137 for highest concentration)	25	19,1
Deltamethrin	5	0,190
Lambda-cyhalothrin	3	0,059

The source of these four substances could not be determined, since they are (or were) all active substances in biocides and plant protection products, and three of them also in animal veterinary medicines. For Velt, these findings were also reason to draw attention to possible chronic cocktail-effects (of combined exposures).

- Poisoning concerns

Another indicator of human exposure are the notifications to the national Poison Centres, which in general indicate individual poisoning concerns. From a supplier and from the Dutch Ctgb, we obtained the following data.

- In the Netherlands in 2024 the Dutch Poison Centre (NVIC) received 1935 notifications of poisoning concerns in relation to biocides. Of these, 410 concerned insecticides in general; 257 concerned pyrethroids (13% of all biocidal notifications) and 30 concerned imidacloprid (1,6%).
- In Spain in 2022 there were 1901 notifications to the Poison Centre (INTCF) related to biocides. Of these, 1066 concerned pyrethroids (56.1% of all biocidal notifications) and 79 concerned neonicotinoids, including (but not only) imidacloprid (4.2%).

The Ctgb notes that these data are very hard to interpret and compare, as methods of application, market sizes and distribution channels play important roles. For example, consumer products that are freely available in supermarkets will give rise to more notifications than specialised products that are sold through specific channels. Also, some products are more prone to misuse than others. For these reasons, in its analysis Ctgb mainly looks at trends and hardly or not at absolute figures as they tend to be less meaningful.

For Belgium, the 'Hoge Gezondheidsraad' (2015) looked into data of the Belgian Poison Centre (Antigifcentrum) and concluded that major problems were rarely reported and that for most reports the symptoms were minor or absent.

- From hazard to risk

Several sources stress the hazards of the five active substances. For example, PAN Netherlands (2025) has put (in a report by the same name) 10 insecticides on the blacklist, as they are 'too dangerous for man and nature to be used in house and garden.' All 5 active substances that are focal to this study are included on the blacklist of PAN-NL.
However, there are only few sources that indicate that consumers and households face more than negligible risks from exposure to these active substances. Among them is the advice of the Belgian Hoge Gezondheidsraad (2015). The High Health-council looked into several exposure scenario's and concluded: "In most cases, exposure remains well below the safe limits established by classical toxicological method. However, it cannot be excluded with certainty that long-term serious adverse health effects, such as endocrine disruption, occur due to low-dose effects and/or synergistic interactions between different agents. This also applies to aggregated/combined exposure to active agents with the same mode of action."

The council also remarks: "Comparing consumers' exposure via ingestion of pesticide residues in their food with their exposure via indoor pesticide application shows that exposure via indoor application can be much greater than exposure via food."

Its overall conclusion: "Notwithstanding the strict regulations, indoor use of pesticides is not always risk-free. Their use should be done with due caution. The use of alternative methods is recommended, namely preventive measures such as mosquito netting, physical control methods such as UV light, and the use of traps, attractants and repellent products, although these alternatives are often less efficient and require further scientific research."
The following section will look deeper into that.

3.3.3 Alternatives for consumer use of these insecticides

To what extent are these products essential for pest control by consumers and what alternatives are available? Below, we look into possible chemical and non-chemical alternatives and into several options to reduce consumer use.

Alternative insecticides / active substances

- Pyrethroids

The effectiveness of a synthetic pyrethroid partly depends on its persistence. The substance has a residual effect, which means that after the fluid has dried the substance remains active. At the same time, this persistence contributes to the hazard the substance poses to the environment. This is particularly the case for lambda-cyhalothrin, the PFAS. According to the supplier, there is no real unique selling point of lambda-cyhalothrin vis-à-vis the other pyrethroids, meaning that it can be substituted by any non-PFAS pyrethroid without loss of effectiveness.

Some suppliers use 'natural' pyrethrins from the chrysanthemum flower. These are presented as less hazardous alternatives for synthetic pyrethroids as they are less stable and less persistent. One sector organisation says it's a problem that these products may not be labelled as 'natural', that there is no legal definition for 'natural products' and that there is no bio-certification for these products.
Several interviewees (amongst whom suppliers of synthetic pyrethroids) point out that pyrethrins are also very harmful for aquatic life.

- Imidacloprid

Imidacloprid is used in gel bait formulations. This formula slows the knock-down effect of imidacloprid so the insects can carry the bait into the nests where it ends the whole colony. This type of formulation is – also due to its very localised application – claimed to be among the safest options available. Its advantages are said to include reduced risk to the environment (practically negligible when applied with bait stations), no risks of mixing, loading, spray drift or overdosing, easy and safe removal and being foolproof. Other than pyrethroids, imidacloprid is said to have no repellence effect and does not lead to resistance. One NGO claims that the remaining ant nest itself can become a source of pollution.

According to producers, there are hardly any feasible chemical alternatives. Many relevant active substances are either candidates for substitution or still under first BPR assessment. When looking at the remaining alternatives that are effective against ants and cockroaches (no larvicide effect) and that are technically suitable for the formulation of gel baits, only few alternatives remain. One producer states that the only alternative would be indoxacarb, but that this substance presents higher human health risks, is more expensive and is distributed by only one supplier. Another producer adds that indoxacarb gives very low efficacy, same as spinosad. This producer mentions Kieselguhr and S-methoprene as possible alternatives, but indicates that the first has high human health risks [sic], the latter is very expensive (10 times the costs of imidacloprid), and both cannot be used in gel-bait formulations.

- Other chemicals

Most interviewees indicate that repellents and attractants (PT19) can be of additional use but cannot be seen as full alternative as they move the pest to a different place. Attractants in combination with physical traps are deemed not suitable for large infestations.

Among attractants and repellents are also several low-risk chemicals (under certain conditions eligible for simplified approval and authorisation). Examples are pheromones and certain food products (concentrated apple juice). These products can also contribute to pest control, though not as a full alternative.

Next to these substances, consumers often use home remedies like bleach, vinegar and soapy products as insecticides. These methods are not safe because it is not the intended use of these chemicals, and they cannot control heavy infestations.

Alternative means to prevent or control
Four types of non-chemical alternatives exist.

- *Anoxia treatments*
  Treatments through the absence of oxygen are not available and feasible for consumers
- *Heat treatments*
  In general, treatments with high or low temperatures cannot be applied by consumers. One exception is the 'old' home remedy consisting of the use of hot water on ants' nests. This can be fairly effective.
- *Mechanical traps*
  Mechanical traps are cheap and easy alternatives to biocidal products. Examples are small cardboard pieces with a sticky substance, a fly swatter, an electric fly swatter, other electrical devices. They can easily be used by consumers and can be effective against small nuisances (possibly increased effective when combined with an attractant). Pesticide producers point out that these alternatives can only work for small infestations in a limited space and will not get rid of the source of the infestation. Therefore, these producers look at mechanical methods as a complementary tool (and not as a substitution) to chemical pesticides, as part of an IPM strategy and as a monitoring tool to assess the scope and nature of an infestation.
  Mechanical methods can also be used for prevention of nuisance by small pests. Examples are screen doors, fly curtains and (not impregnated) mosquito nets.
- *Light traps*
  UV LED and UV Fluorescent tube lights are non-chemical attractants via phototaxis. Some insects such as flies present positive phototaxis as they are attracted by light sources. Other insect such as cockroaches are repelled by light sources. Moreover, light traps are merely attractants that need to be combined with a mechanical or chemical product to actually reduce the infestation. They are not suitable for crawling insects, also not for large infestations and will not get rid of the source.

Options to reduce consumer use
Several policy makers, NGO's and pest controllers present different possible options to reduce consumer use of insecticides. They include:
- Sensibilisation:
  - Promote acceptance: stimulate people to tolerate some personal nuisance for the sake of the benefits of insects for nature and society
  - Provide consumers with information about the risks and effects of the use of insecticides as well as with alternative courses of action to prevent and control small pests.
- Stimulate the development and use of more preventative methods (hygiene, sealing, separation, repellents) (in accordance with IPM strategies).
- Make insecticides less easy up for grabs for consumers; consider behind-the-counter or prescription sales
- Forbid the use of (hazardous) insecticides for consumers. Facilitate the support of professional pest controllers in case of large infestations.

Several interviewees argue strongly against a complete ban for consumers. According to them, consumers will either resort to using harmful home remedies like chlorine or vinegar, or they will go and find ways to get hold of effective products, illegally, via the internet, and without proper control or instruction – which would result in even more risks and damage. Similar actions are expected from hobby farmers.
Other interviewees argue that there are plenty chemical and non-chemical alternatives that are effective for the control of most nuisances and infestations. And real heavy infestations, they argue, must be controlled by professional pest controllers anyway.

3.4 Treated textile

PT18-Insecticides can also be used for the treatment of articles in order to protect articles[43] or their users against insects. Treated articles are regulated in article 58 BPR. Articles can only be treated with biocides based on approved substances.[44] In case the product carries a biocidal claim, information must be presented about – amongst others - the active substance that has been used.

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[43] Insecticides that are used to protect wood against insects are not included in PT18 but in PT8.
[44] On a list recently published by ECHA, all five active substances are mentioned as approved PT18 substances for the treatment of articles. See: https://echa.europa.eu/documents/10162/5604808/treated_art94_data_en.pdf/c0427245-f912-84aa-978a-817ff6bc95db

There is no register of treated articles. Also, it is not mandatory to include possible use for treatment of articles in applications for approval or authorisation. Therefore, to find out whether insecticides based on cypermethrin, alpha-cypermethrin, deltamethrin, imidacloprid or lambda-cyhalothrin are used for treated articles, we carried out desk research and a small field research. It soon became clear that probably the only type of article that is treated by PT18 insecticides, is textile. We therefore also consulted the Dutch sector organisation for the textile industry. All this led us to the following findings.

- We looked at treated outwear clothes and gear (insect repellent and anti-mosquito clothing, sleeping bags and more) that are offered on the internet. We found that most of the textile was treated with permethrin, next to occasional cases where geraniol or lemon eucalyptus oil was used. We found no examples of textile treated with one of the selected five substances.
- Several inventories of treated articles have been made in previous years:
    - PAN Germany (2013) carried out an online survey on consumer articles with designated biocidal function. It found no articles where the use of pyrethroids or neonicotinoids was mentioned.[45]
    - KEMI, the Swedish chemicals agency, carried out a market survey on articles treated with biocides (2016). It mentions one article treated with PT18 deltamethrin (a mosquito net) and one with PT18 permethrin (a horse blanket) (next to several examples of wood treated with PT8 permethrin). Below we will take a closer look at these examples.
    In the overall overview of active substances found in their search in the Swedish Product Register, KEMI found 17 products that contain pyrethrins. It could not, however, mention functions (or function codes) for these articles, which means that it was unclear to them for what possible purpose these active substances were added and for what PT.
    - In 2018 the Swiss Bundesamt für Gesundheit analysed 24 items of clothing – of which 16 with a biocidal claim – for the presence of 11 active substances, including cypermethrin, permethrin and pyrethrin II. Permethrin and cypermethrin were the most frequently found active substances (both in 5 clothing items). Cypermethrin was found in:
        - 3 clothing items without a biocidal claim (2 t-shirts and 1 sport t-shirt).
        - 2 clothing items with biocidal claim (1 functional underwear for children and 1 pair of socks). Remarkably, the – false – biocidal claim for these treated clothes was 'anti-bacterial'.
    - In 2020 ECHA reported on the outcomes of the first harmonised enforcement project on treated articles. It presented overviews of the number and percentages of articles treated with both approved and non-approved active substances. These include:
        - 60 treated articles with the allowed use of permethrin (5% of all inspected treated articles) (next to 1 article that was treated with the use of permethrin that was not allowed).
        - 6 mixtures with the allowed use of permethrin (1%).
        - 2 treated articles with the allowed use of cypermethrin (no further details reported).
        - 1 mixture with the allowed use of cypermethrin.
- In their reports, both KEMI and ECHA look deeper into the issue of 'borderline cases'. These concern cases in which it is open to dispute whether the biocidal effect of the article is its primary or secondary function. In the first case the article is a biocide itself, in the latter case it is a treated article. Several examples of treated textile are borderline cases. The clearest example is the mosquito net that is impregnated with deltamethrin. This article is authorised (also in the Netherlands) as a biocide, since its primary function is to control nuisance from insects by repelling or killing them. Another example is the horse blanket treated with permethrin. KEMI presents it as a border case and decides it is a biocide as – according to the claim in the product's description – it is intended solely to control insects.[46]
- Upon enquiry with the Dutch sector organisation for the textiles industry, only one example came up in which the organisation was consulted by one of its members about treatment of textiles with insecticides. This concerned treatment of a horse nose net with an insect repellent lotion (not consisting of active substances this study focuses on). This too is considered a borderline case.

All in all, we conclude that there are indications that deltamethrin and cypermethrin are used to treat articles (next to permethrin, a synthetic pyrethroid that appears to be often used to treat textiles). We found no indications that neonicotinoids are used for treatment of textile.

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[45] The overview appears to show some bias towards antibacterial products.
[46] This judgement was later confirmed by the European Commission (Executive decision (EU) 2016/903, 8 June 2016)

For deltamethrin, the only example that was found concerns treatment of mosquito nets. In these cases, the mosquito nets themselves are seen as a biocide, as the control of insects is their sole function. Risks for human exposure and washing out into the environment were assessed during authorisation and are warned for in the instructions for use. Users are advised to wash their hands after contact, not to wash the nets because of the risk for the environment, and to keep the nets away from cats.

Cypermethrin appears also to be used to treat textiles. It remains unclear how often this is (still) the case. The findings of the Swiss study indicate that cypermethrin is used in textile products both with and without a (false) biocidal claim. Consequently, (unaware) human exposure to cypermethrin in treated textile is possible as well as environmental exposure through washing out of cypermethrin from textile during laundry.

4. Contribution of the insecticides to water pollution

4.1 Introduction

All five substances on which this study focusses are present in problematic limit-exceeding concentrations in Dutch surface waters. For the Water Framework Directive, cypermethrin and alpha-cypermethrin are priority substances, while deltamethrin, lambda-cyhalothrin and imidacloprid are 'specific polluting substances'. It is therefore important to understand to what extent the use of these substances in PT18 insecticides contributes to the pollution of Dutch surface waters.

This chapter describes what is known about the nature and intensity of this pollution in terms of environmental data (section 4.2), and what is known about the origin of the respective substances in the water (section 4.3). Based on this we attempt to draw conclusions about the relative contribution of the PT18 insecticides based on the five selected active substances to water pollution.

4.2 Environmental data

- *Recent environmental observations*

In 2019 the environmental impact of substances used in plant protection products (PPP) were evaluated by Verschoor et al. (RIVM, 2019b). The effects of these active substances was determined through environmental monitoring data and environmental modelling (Nationale Milieu Indicator). The resulting calculations showed that three synthetic pyrethroids in PPP in particular have a large impact on the quality of surface waters in the Netherlands: deltamethrin, lambda-cyhalothrin and esfenvalerate were responsible for 90% of the environmental burden in surface waters in 2012 and 2016, whereas these three substances represented merely 0.1% of the total use of all PPP in those years. This highlights the significant environmental impact that pyrethroids can have.

The evaluation of Tiktak et al., (2019) on emissions of active substances (from various sources) to surface waters concluded that deltamethrin, lambda-cyhalothrin and imidacloprid stand out the most. On the one hand because of the high number of recorded limit exceedances (imidacloprid) and on the other hand because of their environmental impact (deltamethrin and lambda-cyhalothrin), as stated above.

- *Pesticide Atlas*

The *'Atlas bestrijdingsmiddelen in oppervlaktewater'* ('Atlas of pesticides in surface waters')[47] provides insight into yearly measurements of active substances and whether these exceed the regulatory limits. Specifically, the measured concentrations are compared to the authorization criterion and/or the standards of the Water Framework Directive (AA-EQS, see also paragraph 2.2.3). The extent of exceedance of the AA-EQS of the 5 active substances in Dutch surface waters is shown in the graphs below. It has to be noted that the *Atlas* cannot distinguish between active substances that originate from plant protection products, biocides and other sources. Also, as a result of the selected monitoring locations, the findings are strongly associated with plant protection (RIVM, 2023a).[48]

[47] See: https://www.bestrijdingsmiddelenatlas.nl/atlas/1/1
[48] RIVM recently published an analysis of ways in which the *Bestrijdingsmiddelenatlas* could also play a role in the monitoring of biocides in surface waters (RIVM 2025b).

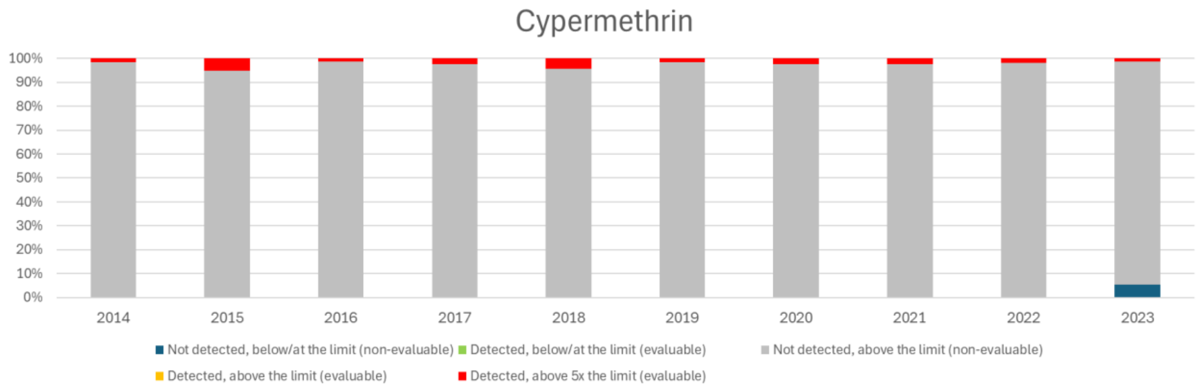

Figure 2: Observations and exceedances of the Environmental Quality Standard in surface water for cypermethrin per year

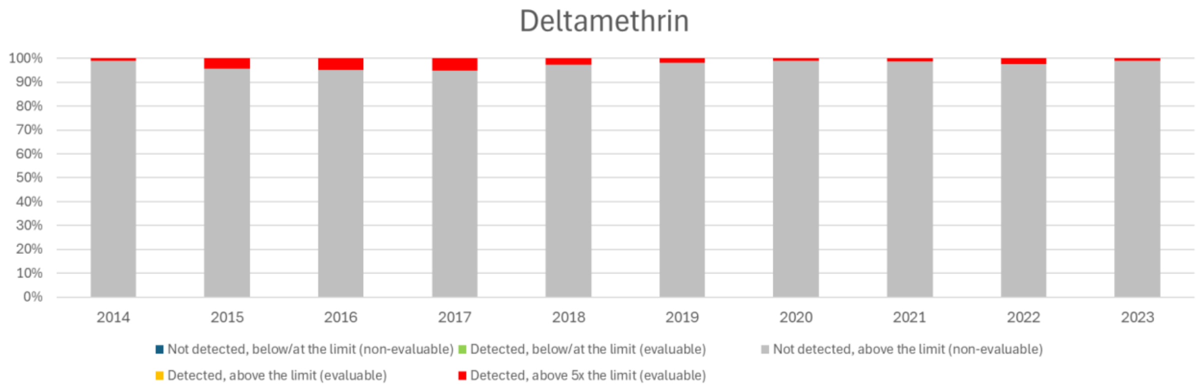

Figure 3: Observations and exceedances of the Environmental Quality Standard in surface water for deltamethrin per year

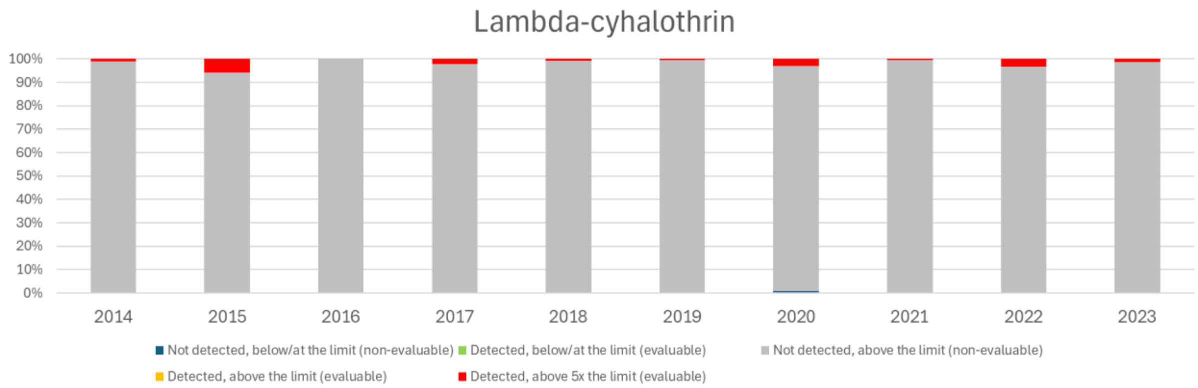

Figure 4: Observations and exceedances of the Environmental Quality Standard in surface water for lambda-cyhalothrin per year

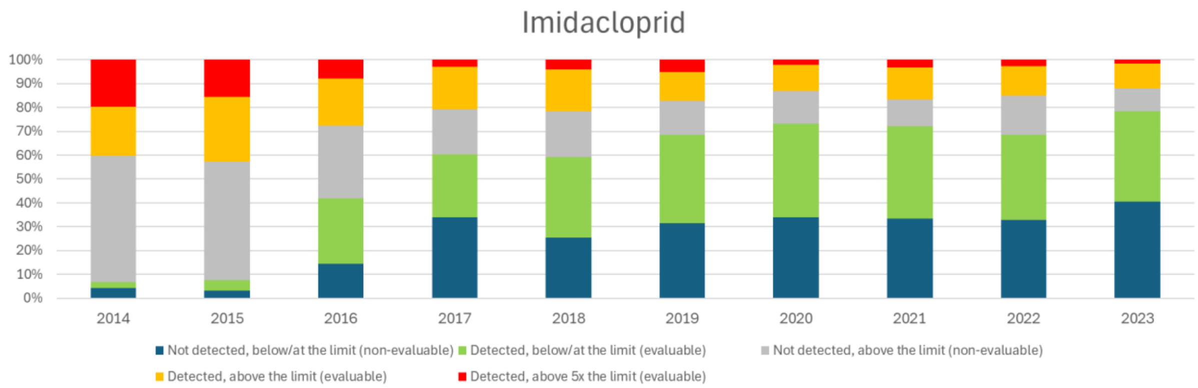

Figure 5: Observations and exceedances of the Environmental Quality Standard in surface water for imidacloprid per year

The graphs in figures 2, 3 and 4 immediately show that a large part of the measurements of the pyrethroids are classified as non-evaluable. In these cases, the standard (the AA-EQS) is below the reporting limit of the laboratories.[49] There is a difference of a factor 2710 for deltamethrin, 155 for lambda-cyhalothrin and 29 for cypermethrin between the reporting limit and the EQS (RIVM, 2023a). This means that for example deltamethrin was not evaluable at 98% of the measured locations in 2023. In these cases the active substance may be present in the surface water above the limit value, despite not being reported. It is therefore not known how frequently the concentrations exceed the limit. Still, each year there are a several measurements that exceed the limit by a large margin (five times or more), indicating that it is very probable that there are more limit-exceedances that are currently a black-box.

To still be able to express the degree of limit exceedance per substance per year, Deltares and the University of Leiden (CML) developed the 'alternative index-value'. The disparity between the detection limit and the limit value is assigned an index-value. Thus, the probability that the concentration of the substance exceeds the detection limit value, yields an index value, which can be used in comparison and ranking of the non-evaluable substances and evaluable substances alike. This new ranking places lambda-cyhalothrin and deltamethrin in the top 10 of limit-exceeding substances, and thus as having a high environmental impact.

The picture for imidacloprid (figure 5) is different from the pyrethroids: a decreasing percentage of the measurements exceeds the limit 1-5 times or exceeds the limit 5 times or more (40% in 2014 to ca. 15% in recent years). Furthermore, in recent years the largest part of the measurements is below the limit value and only around 10 percent of the measurements is non-evaluable. This is different from the situation with the synthetic pyrethroids since imidacloprid is a neonicotinoid. Its reporting limit is in a completely different order of magnitude (it is more easily detected) than the pyrethroids.

Furthermore, for imidacloprid a decrease in limit exceedances over the years is visible. It is likely that this is related to the expiration of the approval for plant protection products for imidacloprid of which the approval is withdrawn from 2018 and the use-up period ended in 2021. The question is whether the remaining limit exceedances will decrease over the coming years due to the ban on imidacloprid in PPP, or that these exceedances are due to other sources, such as biocides. The research by Deltares (2023) names, besides previous use of imidacloprid in PPP, the effluent of WTPs (mixed, urban sources) and bathing dogs (veterinary medicine) as only remaining and therefore plausible sources. Effluent of WTPs is also discussed in the next paragraph.

Within the *Atlas* there is also the possibility to compare the active substances on the basis of their relative toxic pressure on the environment. The mixture toxic pressure is a measure for the total impact value of species toxicity responses to each substance in the mixture. A higher toxic pressure of an individual substance (attributable risk) means a higher negative impact on the environment, relative to other polluting substances. The top 10 of contributing substances to toxic pressure in 2021-2023 is presented in the table below. A higher attributable risk indicates a higher absolute contribution of a substance to effects on aquatic life.

Tabel 17: Table with attributable risk for individual substances in mixtures for 2021-2023 in the Netherlands

Substance	Attributable Risk	Percentage of non-evaluable measurements
deltamethrin	0.060	99.8
lambda-cyhalothrin	0.051	99.7
esfenvaleraat	0.043	96.6
abamectine	0.036	97.2
cypermethrin	0.036	97.2
permethrin	0.030	99.5
tefluthrin	0.017	99.7
cyfluthrin	0.008	99.8
bifenthrin	0.008	15.3
drins4-sum	0.007	6.4

From table 17 it can be seen that despite the fact that pyrethroids are so difficult to detect and test (see percentage of non-evaluable measurements in the table), all pyrethroids that are investigated in this research

[49] The reporting limit is the lowest value that can be reliably determined. Due to differences in measuring equipment and analysis techniques, the reporting limit used may vary per laboratory.

are included in the top-10, underlining their major environmental impact. Furthermore, imidacloprid is included in this ranking at place 22.

- *Emission Registration database*

Yearly emissions are centrally kept in the national Emission Registration Database[50], currently available up to 2022. The reported emissions are not based on measurements in the environment, but are rough, modelled estimations of loads to the environment. These are based on uses/sales of products/substances in combination with emission factor(s) (e.g. the part of the product that ends up in the environment or sewer and from there in the environment).

There is no data for cypermethrin in the database. For deltamethrin and lambda-cyhalothrin, the only sources with emissions are from product use in the agriculture, mostly due to spray drift, in the range of 0,05 – 0,1 kg per year. The different sources and emissions for imidacloprid over the years are presented in figure 6 below

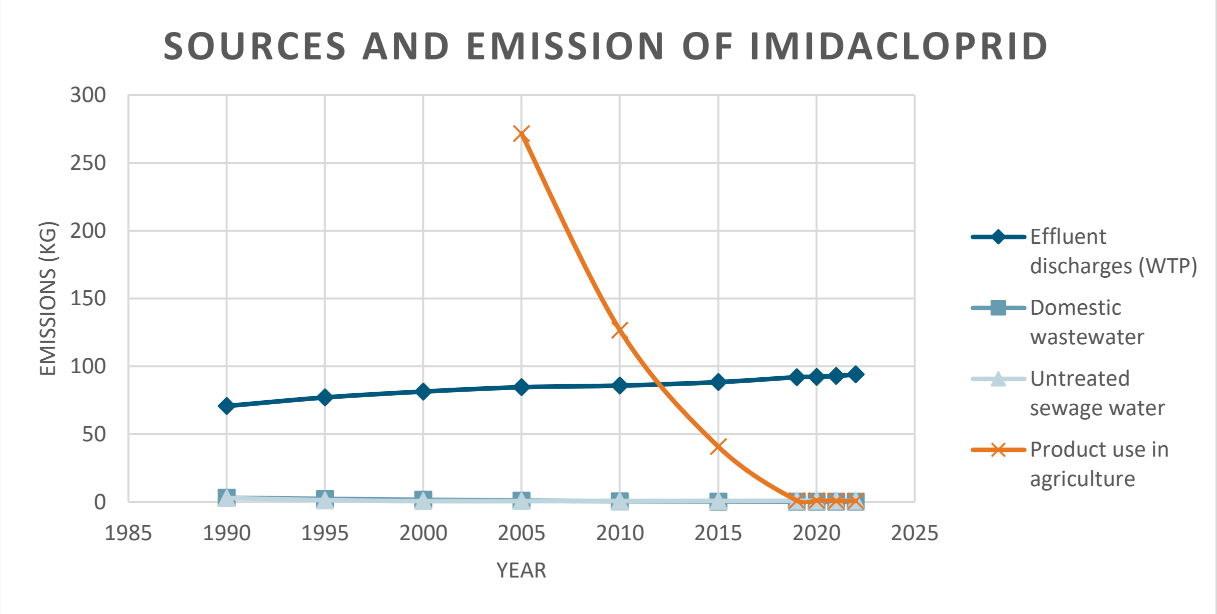

Figure 6: Sources and emissions of imidacloprid according to the Emission Registration database

It is clearly visible that for imidacloprid, product use in agriculture (PPP-use) was previously the main source of imidacloprid to the environment. However, effluent discharges from sewer water treatment plants is currently the main source of imidacloprid emissions, and furthermore, it is slowly increasing.

4.3 Relative contribution of the insecticides to water pollution

4.3.1 PT18 Insecticides and other sources

Several types of uses of products with the five active substances can be distinguished that may lead to the pollution of Dutch surface waters, of which use as a PT18 insecticide (as a biocide or in a treated article) is only one. Other possible uses are: as a PT8 insecticide (for wood preservation), as a plant protection product (either for professional or for non-professional use), or as a veterinary medicine. Figure 7 below illustrates this.

[50] See: https://data.emissieregistratie.nl/export

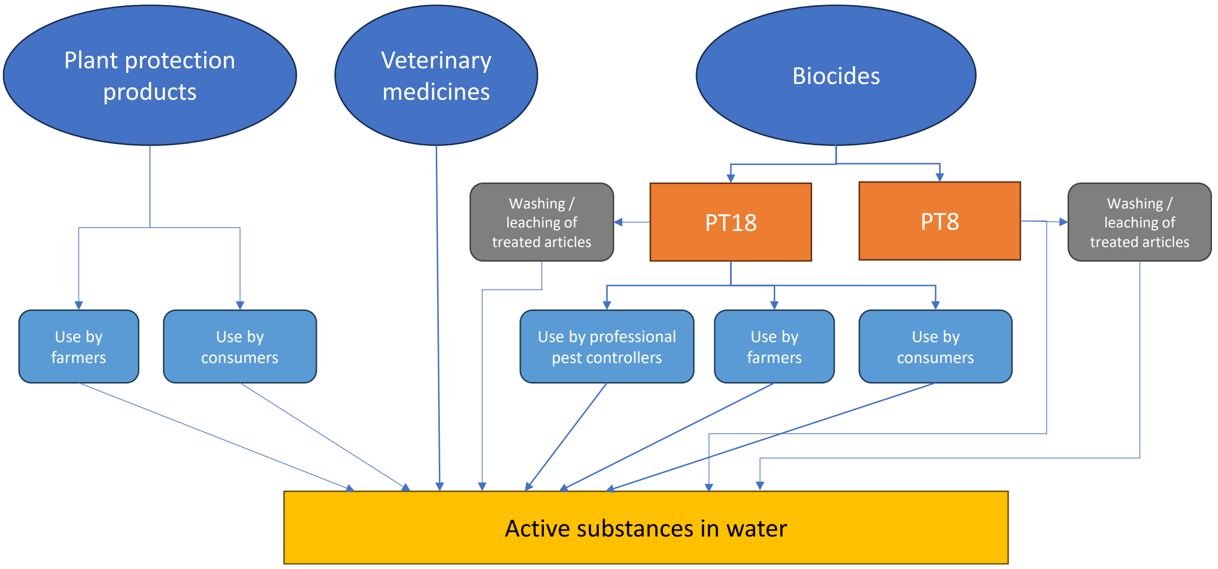

Figure 7: Routes to water pollution with active substances

The table below summarizes for what types of products and uses the active substances are authorised (or are known to be used).

Table 18: Authorised/known uses of active substances

	Biocide PT18			Biocide PT8	Plant protection product		Veterinary medicine
	Professional use	Consumer use	Treated articles	Treated articles	Professional use	Consumer use	
Cypermethrin	(X)*	(X)*	X	X	X		X
Alpha-cypermethrin	X	X					
Deltamethrin	X	X			X	X	X
Imidacloprid	X	X					X
Lambda-cyhalothrin	X	X			X**	(X)***	

*: One new product authorised per 7 May 2025
**: On 8 January 2025 the authorisations of 3 out of 4 plant protection products for professional use were cancelled.
***: On 8 January 2025 the authorisations of all 5 plant protection products for consumer use were cancelled.

The following paragraphs discuss for each of the different active substances what is known about the relative contribution of PT18 biocidal use of the active substances.

4.3.2 The synthetic pyrethroids

Several sources look into the origin of the synthetic pyrethroids in Dutch surface water. Most notably, the *Atlas* reports on correlations between agricultural land use and concentrations of active substances of pesticides in surface water. To be clear: this only concerns agricultural land use, so correlations indicate most of all possible causation by use of plant protection products. Also, the reported data only concern correlations: for cause and effect to be determined additional research is required.

The table below describes the levels of correlations found between agricultural land use and the three synthetic pyrethroids (as the data concern water measurements, no distinction can be made between cypermethrin and alpha-cypermethrin).

Table 19: Correlations between agricultural land use and concentrations of three synthetic pyrethroids in surface water 2021 – 2023 (Source: Atlas bestrijdingsmiddelen in oppervlaktewater)

	Cypermethrin	Deltamethrin	Lambda-cyhalothrin
Green manuring	Very strong	Very strong	Very strong
Sugar beet	Strong	Very strong	Very strong
Other crop	Strong	Very strong	Very strong
Legumes		Very strong	Very strong
Grains		Very strong	Strong
Potatoes		Very strong	Strong
Floristry		Strong	Very strong
Strawberries (and other small fruits)		Present	Very strong
Greenhouse crops	Very strong		Present
Tree nursery		Only just not present	Very strong
Hemp (and other fibre crops)		Very strong	
Vegetable crops	Strong	Strong	Present
Asparagus		Strong	Present
Trade crops		Strong	
Grass seed		Strong	
Leek		Present	Present
Onions		Present	
Corn			Present

N.B.: Empty cells = no correlation found

The table clearly shows several strong and very strong correlations between agricultural land use and surface water concentrations of the three active substances. The same indications follow from calculations with the Dutch Environmental Indicator, as reported by RIVM (2023). This makes it highly plausible – particularly for deltamethrin and lambda-cyhalothrin – that their high concentrations in surface water are related to the use of plant protection products in nearby agriculture. This is confirmed by several interviewees, who point first and foremost to agricultural use of plant protection products with these substances as the cause of limit exceeding water pollution, given the large(r) volumes of pesticides with high(er) concentrations of active substances that are brought directly into the environment this way. All Dutch water boards that we consulted report limit exceeding concentrations of pyrethroids in their surface waters that they attribute to the agricultural use of plant protection products (Ecofide, 2024). One interviewee from a water board proved even to be able to explain all temporary peak levels of imidacloprid that were measured by pointing at cyclical moments in agricultural business operations. These peaks were probably the result of growers who clean their empty greenhouses before crop rotation at the end of the year.

This is all not to say that contributions of other types of use of these substances are negligible. The A*tlas* provides no definite basis for such a conclusion, as it reports on water quality in largely agricultural areas. Also, there is no way to tell from an active substance in the water from what type of source (pesticide, medicine) it originates. There are few (or no) other sources that allow for such analyses.

Still, there are some studies that shine (sometimes different) light on the origins of these synthetic pyrethroids in water.

- *Cypermethrin and alfa-cypermethrin*
  For (alpha) cypermethrin there are only a few (very) strong correlations reported in the Atlas between surface water concentrations and agricultural land use (see table 19, above). At the same time, there are several sources that point at other uses of (alpha) cypermethrin that may contribute to water pollution. These include:
  - Use of these insecticides – and also of veterinary medicinal products – in animal husbandry, from where the active substances can spread to the environment via animal manure (RIVM, 2019b). Insecticides based on alpha-cypermethrin are used on manure or in stables, and thus end up in (slurry) manure. Anti-insecticidal gel medicines can wash off and end up in manure as well. RIVM carried out desk and literature research and asked international experts for their expert opinion. All this led to the conclusion that for alpha-cypermethrin, spread from manure to the environment is a relevant route.

- There is also anecdotical evidence of the relevance of this route. One interviewee mentioned an example of water pollution in rural area that was traced back to horse stables that were treated with alpha-cypermethrin against insects.
- Next to washing of into manure, veterinary medicine can also wash off from animals furs directly into the environment (e.g. in the meadow).
- Cypermethrin is also approved for use as insecticide in wood preservation. The ECHA database mentions 79 related authorised biocidal products. Interestingly, none of these products appear to be authorised for use in Netherlands. This is confirmed by the Ctgb database. Nevertheless, it is possible (and even plausible) that wood that has been treated with cypermethrin is imported and used in the Netherlands, which – in theory – could lead to washing and leaching of cypermethrin to the environment. The Assessment Report of cypermethrin[51] for wood preservation indeed states that there is a risk of leaching of cypermethrin to the environment when the treated articles are used in outdoor constructions near or above water, and that, therefore, these applications may not be allowed in the SPCs. Since the treated articles with cypermethrin do not originate from the Netherlands, it is unknown whether the treated wood is used correctly according to regulations. The possibility of emissions of cypermethrin to the environment from this source, can therefore currently not be ruled out.

All the possible routes described above, suggest that environmental contamination by cypermethrin and alpha-cypermethrin in biocides and veterinary medicine, if any, is mainly to be found in rural and wetland areas where animal husbandry takes place and where preserved wood is used in contact with or close to water. One particular potential route has been found, however, that would lead to pollution in urban areas.

- This concerns the washing off from textile (clothes) treated with cypermethrin, as was mentioned in section 3.5 of this report. One source might indeed contain indications that environmental pollution with cypermethrin occurs along this route. RIVM (2023, p. 55) presents data from the '*Atlas bestrijdingsmiddelen in oppervlaktewater'* over 2019-2021, in which some correlation is found between concentrations of cypermethrin in surface water and use in urban areas. In the same report it is noted that cypermethrin is not quantified in any of the samples recorded in the WATSON database that contains all measurements for in- and effluents of wastewater treatment plants. The authors note that 'this could indicate either analytical difficulties or (its) absence' (RIVM, 2023, 57).

– *Deltamethrin*
For deltamethrin there are several (very) strong correlations reported in the *Atlas* between surface water concentrations and agricultural land use (see table 19, above). Additionally, RIVM (2023) points at substantial estimated yearly emissions of deltamethrin to surface water according to the Dutch Emission Registration, almost entirely due to drift of plant protection products into surface waters. However, also for this active substance there are sources that point at other uses that may contribute to water pollution.
  - Deltamethrin is used in veterinary medicines. RIVM (2023) describes (reversed) calculations that have been carried out, that indicate (with a level of uncertainty) that emissions of <10% of the sales volume to surface water would be sufficient to exceed the environmental risk limit. Combined with information on excretion by pets and emissions by e.g. washing of dogs, it is concluded that 10% emission of the total use volume of deltamethrin is realistic (RIVM, 2023, 36-37).
  - Even though the *Atlas* does not report correlations between deltamethrin concentrations in surface waters and urban use, in the Watson database deltamethrin is the only synthetic pyrethroid that is detected in the influent of Dutch wastewater treatment plants (in 3 out of 62 measurements) (none in the effluent). This can be seen as an indication of the use of deltamethrin by the general public, according to RIVM (2023, 56). Most plausibly, this concerns the use of deltamethrin containing veterinary medicine in households or the application in households of insecticides based on deltamethrin (either by consumers or professionals).

– *Lambda-cyhalothrin*
Also for lambda-cyhalothrin the *Atlas* reports several (very) strong correlations between surface water concentrations and agricultural land use (see table 19, above). Similarly, RIVM (2023) points at Dutch Emission Registration estimations of substantial yearly emissions of lambda-cyhalothrin to surface water,

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[51] Evaluation of active substances; Assessment Report Cypermethrin cs:trans/40:60, Product type 8 (wood preservative); 12 July 2013, Belgium

almost entirely due to drift of plant protection products into surface waters. Additionally, also other uses may contribute to water pollution.

- Lambda-cyhalothrin is also used as PT18 insecticide in animal husbandry, from where the active substances can spread to the environment via animal manure (RIVM, 2025a). Insecticides based on lambda-cyhalothrin are used on manure or in stables, and thus end up in (slurry) manure. RIVM carried out desk and literature research and asked international experts for their expert opinion. All this led to the conclusion that for lambda-cyhalothrin spread from manure to the environment is a relevant route.
- Even though Lambda-cyhalothrin based insecticides are said to be predominantly sold to consumers (see chapter 3.3), no correlations between surface water concentrations and urban use are reported in the *Atlas*, nor does the Watson-database contain data of positive measurements of lambda-cyhalothrin as influent to Dutch wastewater treatment plants. Again, this could indicate either analytical difficulties or the absence of the – non-evaluable – active substance.

It can be expected that the relative contribution of the biocidal use of lambda-cyhalothrin to Dutch water pollution will become more and more clear (and relevant) when its use in plant protection products is terminated (as most of its authorisations for plant protection products are already withdrawn).

4.3.3 Imidacloprid

The origin of imidacloprid in surface water has been studied from different angles. This is particularly the case as the relative contribution of the (legal) use of imidacloprid in plant protection products is strongly declining, due to the expiry of its EFSA approval per 1 December 2020 (with respite until the end of 2021). Also, even before 2021 not all concentrations of imidacloprid in surface water exceeding water quality limits could be attributed to agricultural use – and it still cannot.

This, for example, comes to the fore in the *Atlas*, in which only one (in this case: strong) correlation was found between agricultural land use and concentrations of imidacloprid in surface water in the period 2021 – 2023 (see table 20). This concerns the land use for greenhouse crops. This correlation makes good sense, as in the last years before the expiry date of December 2022 (as from April 2018) plant protection products were only authorised for use in permanent, closed greenhouses.

Table 20: Correlations between agricultural land use and concentrations of Imidacloprid in surface water (Source: Atlas bestrijdingsmiddelen in oppervlaktewater)

	Imidacloprid
Greenhouse crops	Strong

A detailed study on the possible origins of imidacloprid in Dutch surface waters was carried out by Deltares (2023). This report also reports to Watson database data which show that imidacloprid has been measured above reporting concentrations in 82% of the influents and 88% of the effluents of Dutch wastewater treatment plants. This – as noted above – can be seen as an indication of the use of imidacloprid by the general public.

Spatial analyses carried out by Deltares indicated that – even though the highest exceedances of the water quality limit for imidacloprid are found on greenhouse locations – there are several locations where it is highly plausible that these exceeding concentrations are caused by use of other products than plant protection products. Plausible routes are:

- Washing (in- or outdoors) or shedding of pets with anti-flea medication;
- Washing off or cleaning of biocides used against ants and cockroaches;
- Bathing dogs due to runoff of the flea agent from their fur or flea collar (the study identified some measuring points where this might play a significant role).

Deltares remarks that based on currently available measurements the exact contribution of the use of imidacloprid via the different routes cannot be quantified. It was established, however, that the use of imidacloprid as an anti-flea medicine can serve as a full explanation of the concentrations measured in the effluent of wastewater treatment plants.

Similar reports on imidacloprid concentrations in urban wastewater come from Germany (UBA 2020, 2025) and the United Kingdom (in: Wells and Collins, 2022). The UK findings triggered two studies that specifically looked into the contribution of parasiticides, amongst which imidacloprid, to water pollution. Wells and Collins carried out a systematic review study (based on screening of 17.207 published articles, with 690 included in the final evidence synthesis)), that led them to the conclusion that *"increasing research into the environmental pollution of freshwater bodies provides evidence that imidacloprid (…) (has) been found in water areas where an agricultural-use source is extremely unlikely.*" They point at 'treated dogs bathing or swimming' that can induce continuous low-level exposure. There is no hard evidence of this, however, due to lack of safety studies. They continue: "*A lack of safety studies is justifiable if there is negligible risk of parasiticides entering the environment, but with millions of doses sold in the UK every year and any mitigation methods reliant on pet owner compliance and cooperation, this is unlikely."*

Secondly, following up on signals of high imidacloprid (and fipronil) concentrations in UK surface waters and a confirmation by the UK Water Industry that wastewater is a major entry pathway for these chemicals, a UK study was carried out to quantify down-the-drain emissions of 98 dogs treated with spot-on ectoparasiticides containing fipronil or imidacloprid, through bathing, bed washing and washing of owners' hands. Both chemicals were detected in 100% of washoff samples, with bathing accounting for the largest emissions per event (up to 16,8% of the applied imidacloprid). Modelled to account for the frequency of emitting activities, owner handwashing was identified as the largest source of down-the-drain emissions from the population overall, with handwash emissions occurring for at least 28 days following product application and an estimated 4,9% of imidacloprid in dog spot-ons passing down the drain via this route (Perkins et al., 2024).

All this suggests that next to the (historic) use of imidacloprid in plant protection products, veterinary medicines are the next a plausible source of water contamination with this chemical. So far, little evidence is reported of the use of PT18 insecticides with imidacloprid being a source.

The interviewee from the companion animal sector stresses the importance of the availability of effective anti-flea medication in the interest of public and animal health (as fleas cause skin problems and transmit diseases) and welfare. According to him, the risk awareness within the companion animal sector is high. He points to explicit general information and concrete recommendations from the sector to dog owners to take off anti-flea collars before letting dogs swim, or to only allow for swimming after a certain period of time after treatment. The sector believes continuous sensibilisation and information of pet owners is the only way to raise awareness and make them act responsibly. A ban or a restriction will be counterproductive in their eyes, as it will lead consumers to order online products that may be even more harmful, come with less information and will be used uncontrolled.

An article in a professional journal (Overgauw, 2021) describes the lack of alternatives to the anti-flea medication:

- Essential oils have not proven to be effective and can cause allergenic reactions or even be toxic to companion animals.
- Moulds can be effective against fleas and fleas eggs but have not been developed to be used for pets.
- Vacuuming can be a highly effective method to remove fleas and fleas eggs from the room (even without further treatment), but this hardly and only indirectly releases the burden of the companion animal.

Magnetic tokens and ultrasonic sound devices are sometimes promoted for use against fleas and ticks. However, their efficacy has never been demonstrated or proved (and sometimes it proved that no sound was produced whatsoever). If ultrasounds were produced, it would be animal-unfriendly because dogs and cats can usually hear these high-pitched sounds.

5. Conclusions

5.1 Introduction

The previous chapters presented the findings of the desk research and consultation with stakeholders on the use of and alternatives to 5 active substances (cypermethrin, alpha-cypermethrin, deltamethrin, imidacloprid, lambda-cyhalothrin) that are used in insecticides, acaricides and products to control other arthropods (PT18). Based on this, in the following paragraphs conclusions are drawn about the authorizations for, the use of, the risks (including risks related to water quality) of and the alternatives for insecticides based on the 5 active substances for PT18. Finally, we deduce from all this what the consequences would be of renewed approval or of a decision to withhold approval for the active substances for this application.

5.2 Authorisations of insecticides with selected active substances

The first main question was: Which insecticides based on these active substances are currently authorised and for which specific applications?

The conclusions are:
- Insecticides based on these active substances are approved for both professional and non-professional use.
- Depending on the target organism, products may be approved for indoor use only or also for outdoor use.
- Insecticides with cypermethrin (1 product) are authorized for:
  - Indoor curative treatment in cracks and crevices against German cockroach, oriental cockroach, black garden ant, and other crawling insects;
  - Indoor curative treatment in wasp nests;
  - Outdoor curative treatment in ant nests.
- Insecticides with alpha-cypermethrin (2 products) are authorized for:
  - Only authorized in animal housing;
  - Indoor curative treatment on surfaces and in cracks and crevices against German cockroach, black garden ant, housefly, stable fly, mosquitoes, and wasps.
- Insecticides with deltamethrin (18 products) are authorized for:
  - Indoor curative treatment on surfaces and in cracks and crevices against ants, mosquitoes, woodlice, cockroaches, wasps, flies, bed bugs, spiders, silverfish, and other crawling insects;
  - Indoor curative treatment in wasp nests;
  - Outdoor curative treatment in ant nests.
- Insecticides with imidacloprid (11 products) are authorized for:
  - Indoor curative treatment as baiting formula against ants, flies, and cockroaches;
  - Outdoor curative treatment in ant nests.
- Insecticides with lambda-cyhalothrin (2 products) are authorized for:
  - Indoor curative treatment against ants and flies;
  - Outdoor curative treatment in ant nests.

5.3 Use of these active substances (in insecticides)

The second main question was: what is known about the current use of insecticides for PT18 based on the 5 active substances cypermethrin, alpha-cypermethrin, deltamethrin, imidacloprid and lambda-cyhalothrin, both qualitatively (nature of application, field of application, function) and quantitatively (volumes)?

The conclusions in qualitative terms are:
- The insecticides in question are widely used for the control of small pests by private individuals (non-professionals) and professionals (qualified Pest Control Officers (PCOs) and agricultural use).
- Indoor use on surfaces and in cracks and crevices occurs in homes and commercial buildings. Commercial buildings include all possible sectors, such as agricultural businesses, food industry, feed companies, hospitality, retail, healthcare facilities, transport, storage and distribution companies and office locations, both for business customers and for government agencies.
- Outdoor use is limited to targeted applications in ant and wasp nests, as well as in all kinds of private and business locations.

- Deltamethrin is the most widely used active ingredient in insecticides used as liquids or powders for professional application.
- Imidacloprid is used by both private and professional users, mainly as an attractant (gel or granulate) or - especially on agricultural farms - as a coating agent (water-dispersible granulate).
- Besides their use in insecticides, there are several other uses in which these active substances are applied (see also table 21):
    - Some of these active substances are used in plant protection products.
    - Some substances are used in veterinary medicines.
    - During the investigation, indications were found that cypermethrin in particular can be found as an active substance in treated textile, such as clothing.
    - No products for wood preservation (PT8) containing cypermethrin are authorised in the Netherlands. However, wood is treated with these products in other EU Member States and can then be imported into the Netherlands.

Table 21: Five active substances and their applications in the Netherlands

	Biocide (PT18)		Biocide (PT8)		Plant Protection Product	Veterinary medicine
	Products	Treated articles	Products	Treated articles		
Alpha-Cypermethrin	Yes	No	No	No	No	No
Cypermethrin	Yes	Yes	No	Yes	Yes	Yes
Deltamethrin	Yes	No	No	No	Yes	Yes
Imidacloprid	Yes	No	No	No	No	Yes
Lambda-cyhalothrin	Yes	No	No	No	Yes (Expires)	No

The conclusions in quantitative terms are:
- Since there is no registration of quantities of biocides traded in the Netherlands and because (most) companies regard this information to be confidential, it is not easy to provide an accurate picture of the quantities of insecticides traded, both non-professional and professional.
- Some information has been obtained about the amount of cypermethrin, alpha-cypermethrin, deltamethrin, imidacloprid and lambda-cyhalothrin as active substances traded in other member states.
- The quantities of active substances show large differences between countries. There are also large unexplained differences in the registered quantities per country between different years.
- Since Dutch quantity data are lacking and data from other countries that have shared information are difficult to interpret (for instance due to high variability between and within data sets), no quantitative conclusions can be drawn based on these data.

5.4 Risks of using these insecticides

The next main question is: what is known about the dangers and risks of using these products?

The conclusions are:
The main concern with these products is in their hazardous properties for the environment.
- The hazardous properties of the different active substances for human health are:
    - Cypermethrin is harmful if swallowed and may cause respiratory and/or (allergic) skin irritation. Cypermethrin is under assessment as endocrine disrupting.
    - Alpha-cypermethrin is toxic if swallowed and may cause respiratory irritation. Prolonged or repeated exposure may cause damage to organs.
    - Deltamethrin is toxic if swallowed or inhaled and may possibly cause skin sensitizing.
    - Imidacloprid is toxic if swallowed and is under assessment as endocrine disrupting.
    - Lambda-cyhalothrin is harmful if swallowed or in contact with skin and even fatal if inhaled.
- Hazardous properties for the environment are:
    - They are all very toxic to aquatic life (acute), as well as very toxic to aquatic live with long-lasting effects (chronic). This is the reason why cypermethrin and alpha-cypermethrin are priority substances for the Water Framework Directive, and the other three substances are characterised as ‘specific polluting substances’ in the Netherlands.
    - Lambda-cyhalothrin and its metabolite TFA are PFASs, a.k.a. ‘forever chemicals’ due to their persistence (hardly or not biodegradable).

  - All substances act not only on the unwanted pests but also affect insects that are perceived as beneficial such as bees. They are all suspected of contributing to the worldwide decline of bee populations. Also, especially other invertebrates may be affected, leading to disturbances in the soil ecosystem, food webs and biodegradation cycles.
- There is evidence that against all 5 substances resistance can occur. Resistance of the common housefly against imidacloprid has been found in the EU (but not in the Netherlands, and not among ants and cockroaches). For the other 4 substances, resistance has been found among mosquitos, common houseflies, bed bugs and cockroaches (not among ants and spiders), again in the EU, but not in the Netherlands.
- According to professional interviewees, all PCOs are highly trained and work in accordance with the statutory instructions for use (SPCs) and use the prescribed personal protective equipment. Under these circumstances they assume that the risks for humans and the environment are properly controlled. However, it should be noted that water quality standards within the Water Framework Directive are stricter than standards within Ctgb authorisation, which may lead to use (by professionals) in accordance with SPC requirements that still results in exceedances of the WFD-limits.
- Most interviewees think the risks of agricultural use of these insecticides as biocides are higher than of use by trained professionals. Firstly, agrarians do not require training to be allowed to use these insecticides on their own farm. Some of them have had training as part of the licensing requirements for applying plant protection products ('spuitlicentie'). This training includes – to a certain extent – the safe use of insecticides. Others have had no such training whatsoever. Secondly, the use of these insecticides mostly takes place in rural areas, close to nature and surface waters, and in animal farms where rinsed-off insecticides can be spread to the environment via manure.
- Many interviewees believe that the risks of consumer use are relatively highest. Consumers are known to be largely unaware of the risks, to not always read and follow instructions and to tend to use too high doses in order to be on the 'safe' side (meaning: to obtain fast and effective pest control) (even though they generally use rather 'foolproof' products (ready-to-use, bait boxes) with relatively low concentrations of active substances, and mainly for indoor use). There are indications that consumers themselves run more than negligible risks from these products, as indicated by measured background concentrations, by poisoning concerns reported to Poison Centres and by analysis of long-time serious adverse health effects by experts.

5.5 Alternatives to these insecticides

From a preventative (integrated pest management) perspective, the main questions are: what is the risk awareness of the various actors dealing with insecticides based on these 5 active substances, what are the current possibilities for insect control and for substituting cypermethrin, alpha-cypermethrin, deltamethrin, imidacloprid and/or lambda-cyhalothrin, can their use be reduced, and what drives and hinders substitution?

The conclusions are:

- Risk awareness is said to be high among professional pest controllers and professionals. Risk awareness is lowest among private users (although this seems to be increasing), while agricultural users are somewhere in between. This depends, for example, on whether they have the licensing requirements for application of plant protection products and have already paid attention to the dangers and risks of biocides during their training.
- There are several non-chemical alternatives for the control of insect infestations, which can be divided into preventive, mechanical, biological and physical control techniques. However, in case of large infestations these might not be sufficient, and a professional pest control treatment – with the use of (these) insecticides – might be necessary. Additionally, not all treatments can be applied in all situations, which is true for both chemical and non-chemical methods.
  - <u>Preventive control</u> measures include:
    - Good hygiene to prevent attracting insects and to prevent food availability to these insects.
    - Structural adjustments to prevent insects from entering or hiding.
  - <u>Mechanical control</u> measures include:
    - A simple solution such as a fly swatter or a vacuum cleaner, but also liquids that block the oxygen supply in stagnant water or that form a microcapsule around insects and thus immobilize them.
  - <u>Biological control</u> measures include:
    - Natural enemies including predators, parasites (including parasitoids), and pathogens.
    - Introducing natural enemies on location, such as predatory mites or parasitoid wasps.

    - Adjusting the habitat so that insectivorous birds and bats can settle.
    - Certain types of bacteria and fungi.
  - Physical control measures include:
    - Control measures by adjusting the ambient temperature, air humidity or by removing oxygen from the environment.

- IPM as a starting point: All professional interviewees indicate that they take integrated pest management (IPM) as a starting point for controlling insect populations. They do not exclude the use of insecticides but see this as a last resort. All non-chemical alternatives are used or at least considered. Often a combination of non-chemical control and a (limited) use of insecticides is chosen. In practice, multiple methods are often used one after the other or alongside each other to be effective and to guarantee a long-term result.
- More alternative methods for consumers: Some parties mention that they see a shift towards alternative, less harmful means and methods employed by consumers , though others see no change in this regard. It is, however, clear to all parties that the range of alternative options has grown.
- Alternatives for consumers are largely available: For local and small infestations consumers have several alternatives available to control insect pests. According to several interviewees, the current availability of chemical insecticides with easy use and quick result (unnecessarily) draw consumers towards these options.
- Niche solutions are sometimes available for professionals: There are niche-solutions (for instance heat- or low oxygen-treatment and displacement of wasp-nests) but these are not applicable in every pest situation. These methods can be seen as additional tools in the PCOs toolbox, but not a complete alternative for insecticides.
- Barriers to calling in the help of professionals: There are barriers for clients (consumers, institutions and companies) to call in the help of PCOs. One is that clients expect a quick and easy solution, i.e. insecticide treatment, while PCOs often employ a more thorough approach, including monitoring (in a broader area), and implementing preventative measures and alternatives to the use of insecticides, aimed at both removing the infestation and preventing a re-occurrence. These methods may be more expensive and not as quick as a client might want. This may be a barrier, in which case it is cheaper (and faster) to resort to a PCO with lower professional standards or to buying and applying a consumer insecticide.
- No business case for alternative chemicals: Innovation toward alternative active substances is slow or even at a standstill, due to high costs of research and development, as well as of high costs, long lead times and uncertain outcomes of approval and authorisation procedures, resulting in failing business-cases vis-à-vis small business margins and turnovers in biocide markets (particularly when currently available products are allowed and sufficient).

5.6 Contribution to water pollution

The main question in relation to the surface water quality problem posed by these substances is: to what extent do historical, current and future use of these PT18 insecticides and treated articles contribute to the problems with surface water pollution? (Also in relation to the use of the 5 active substances in other types of products?).

As shown in table 22 below, the contribution to surface water pollution of these active substances differs, but in three of these four groups the use of these substances in plant protection products is found to be the leading contributor, with (in two groups) the use in veterinary medicine taking second place.

Table 22: Four active substance groups (since cypermethrin and alpha-cypermethrin cannot be measured in water individually) their uses, and their contribution to water pollution, where the most likely contributor for water pollution is marked 1, while less likely (or smaller) contributors are marked 2 or even 3

	Biocide PT18 Insecticide		Biocide PT8		Plant protection product	Veterinary medicine
	Professional use	Consumer use	Treated articles: textile	Treated articles: wood		
(Alpha) Cypermethrin	2 (agricultural use)		3 (found in urban areas)	3	1	2
Deltamethrin	3 (found in water in both agricultural and urban areas)				1	2
Imidacloprid	Question mark (ant bait stations)				(1) Remnants from historic use	1
Lambda-cyhalothrin	2 (agricultural use)	Question mark (not found in urban area's)			1 (but soon to be historic)	

The conclusions are:
- Particularly for deltamethrin and lambda-cyhalothrin, all measurements indicate that the largest part of the limit exceedances in surface water with the active substances concerned, originates from plant protection products. Most of the interviewees, including authorities, professional users, wholesalers and NGOs, share this view. In addition, and particularly for imidacloprid, veterinary medicines are a significant potential source. The prevailing opinion is that the share of biocides, based on the 5 active substances included in this study, is small – although not necessarily negligible.
- There is a lack of insight into the origin of active substances where contamination with the active substances is found. Several interviewees call for more research in this respect.
- Potential emission of insecticides (as PT18 biocide) to surface water occurs mainly by run-off or by washing out. This can occur by cleaning treated parts with water after indoor use or by washing treated articles, after which the water flows into the sewer. Another possibility is when the insecticides have been applied in barns, after which the manure is spread over the land and comes into contact with the surface water via the soil (or directly).
- Additional emissions can take place as a consequence of illegal use, for instance from the use of leftover supplies of banned plant protection products, from using excessive doses of insecticides, from use in non-authorised locations, from (early) wet-cleaning of treated places or from discharging excess spray liquid or rinse water (after cleaning of application equipment) into the sewer.

5.7 What if approval is granted or withheld?

The final question is: what will be the impact of renewed approval, restrictions or a decision to completely ban (in the EU and/or in the Netherlands) the use of cypermethrin, alpha-cypermethrin, deltamethrin, imidacloprid and/or lambda-cyhalothrin as active substances for insecticides?

The conclusions are:
- <u>Renewed approval and no additional restrictions</u>: If approval is renewed and no additional restrictions are introduced, these products will be sold and used as they currently are. Many stakeholders (producers, suppliers, retailers) state: if a product is allowed to be sold and used, we will sell them. When a product is authorized by Ctgb, people (including consumers) assume it is safe and can be used.
  Growing awareness by the public and by PCOs could have some effect on the total use of insecticides, but there are sparse indications that this actually results in reduced sales and use.
  A continuation of the current situation – also including a continuation of the use of these substances in PPP and veterinary medicine – will not reduce water pollution with these active substances but might even increase, due to build-up of persistent chemicals. The same holds true for pollution with TFA (PFAS) through lambda-cyhalothrin.
  A reliance on the same active substances will most likely, in the long run, lead to resistant pest species.

- <u>A Complete ban of these insecticides</u> may lead to a certain reduction of risks for humans and for the environment (including risks to non-target species and water pollution), although the continual use of plant protection products and veterinary medicine with these active substances may still have their effect. Lambda-cyhalothrin (a PFAS-chemical) can be substituted by any other synthetic pyrethroid, as this active substance appears not to have any unique selling point.
  Other probable effects are: a reduced toolbox for PCOs, which might result in the inability to manage certain pests, leading to subsequent risks e.g. spread of disease-carrying insects in the future. A reduced toolbox will increase a dependency on the few available options, increasing the chance of resistance build-up for those substances.
  The inability to control pests could in some cases pose a risk for public health or food safety.
  The margins of producers are reduced, resulting in less funds for innovation in (low risk) chemical insecticides.
  However, a growing demand for non-chemical alternatives could stimulate innovation in this field.

- <u>Restrictions</u>: if a continuation of the current situation is unwanted and if a complete ban of these insecticides has too many side-effects, certain restrictions can be considered. Below we list several of them, including possible side-effects.
  - The first option is to restrict the use of these active substances in PPP and veterinary medicine. Although these products are outside of the scope if this research project, there are many indications that the risks of using these products outweigh the risks of using PT18 insecticides.
  - Within the BPR, it would be wise to examine whether PFAS-containing actives, or actives with PFAS as metabolite, can be restricted (parallel to REACH restrictions).
  - Another option is to ban these products for consumer use. There are plenty alternatives for consumers to deal with nuisances and small infestations. In case of more serious infestations, consumers can hire PCOs. When it comes to possible side-effects, some interviewees point at the costs associated with hiring PCOs, which may prevent consumers from doing so, allowing the infestation to worsen. If at a later stage a PCO is involved, the total scope of the problem is larger, increasing the chance and quantity of insecticide use.
    Additionally, if consumers cannot buy insecticides legally, this may give rise to illegal import of non-authorized insecticides , as well as to the use of home remedies (bleach, vinegar).
    Finally, there are some parties stating that the consumer market is a necessity for authorization holders to even invest in the Dutch biocidal market. Others contradict this, pointing to some companies that solely focus on the PCO-market and stating that innovation in the field of biocides mainly depends on PPP sector.
  - Another option would be to create a certain barrier for sale of these products to consumers by only allowing sales over the counter or on prescription, which could add to the awareness of the risks of these products.
  - A next option for a restriction could be the introduction of a certification requirement for agricultural users of insecticides: a certificate of professional competence (training and examination) as a condition for the use of insecticides as biocides. Attention should be paid to IPM, prevention options, alternatives to insecticides and the risks with regard to the active substances of the insecticides, comparable to the training requirements for pest control operators.
  - Analog to the legal restrictions on the professional use of rodenticides in the Netherlands, where the IPM method is required, similar regulations for the professional use of insecticides could be considered to restrict the use of insecticides and to give guidelines for their use.
  - Awareness and targeted communication, both to professional users (including agrarians) and to consumers, could stimulate the use of alternative control methods. Sensibilisation and improving general knowledge , concerning IPM and the alternatives to insecticides, the chemicals found in insecticides, the risks associated with their use and the usefulness and importance of insects for natural environment, could help to reduce insecticide application within all user groups (consumers, professionals, and agricultural users).
  - Active stimulation of non-chemical methods and of preventive measures and control methods with low risk alternatives (next to restrictions of the use of chemical products) could further enlarge the availability of alternatives and reduce the impulse to use insecticides for all user groups.
  - More measurements to trace sources of water contamination, for example by investigating influents and effluents at sewage treatment plants, could give insight in the origin of active substances. If

possible, adding chemical markers to distinguish between sources (product types and user types) would give direct insight in the relative contribution of the different sector(s) applying these active substances. This would allow for emission routes to be better mapped and controlled.

Appendix 1 List of sources

Appendix 1 List of sources

Consulted organisations

Suppliers and/or authorisation holders
Envu Environmental Science (previously Bayer)
Arysta LifeScience Benelux SPRL
MYLVA S.A.
Syngenta Crop Protection AG
ZAPI S.p.A.
Compo Benelux
Denka International Nederland

Wholesalers, applicants, training companies and trade organizations
Centraal Bureau Drogisterijbedrijven, CBD (Central Bureau of Drugstore Companies)
Dibevo - domestic animals (trade association for pets)
Raad Nederlandse Detailhandel (Dutch Retail Council)
Thuiswinkel.org
Tuinbranche Nederland (garden trade organization)
Vereniging van Winkelketens in de Doe Het Zelf branche, VWDHZ (Association of DIY Retail Chains)
SBK (trade association for the veal sector)
Land- en Tuinbouworganisatie Nederland (LTO)
Modint (Dutch clothing and textile industry)
Platform biociden
Van Eck BV
Edialux
EUROstyle
Eco Worldwide Solutions (EWS)
Hofman Animal Care
Killgerm Benelux
Stichting Lestrix (Na)Scholingen
NVPB
Anticimex
Rentokil Nederland
Royal Brinkman
Biohuis
Ecowesp
Drooghout Gendringen
Platform Plaagdierbeheersing Nederland (PLA..N)
ZUNGO Pest Control
Vee & Logistiek
Koninklijke Horeca Nederland (KHN)
Vereniging van Nederlandse Gemeenten (VNG)
Nederlandse Vereniging van Ziekenhuizen (NVZ)

Experts
FOD Volksgezondheid Belgium
Ministry of Health, Republic of Croatia
Hoogheemraadschap van Delfland
Experts on the Bestrijdingsmiddelenatlas
Independent expert

NGO’s
Wespenstichting
Velt
MilieuCentraal

Stichting Avined (partnership Dutch poultry sector)
Natuur & Milieu
Pesticide Actions Network Netherlands (PAN-NL)

<u>Consultations:</u>

College voor de toelating van gewasbeschermingsmiddelen en biociden (Ctgb)	Authorising body
Rijksinstituut voor Volksgezondheid en Milieu (RIVM)	Knowledge institute
Rijkswaterstaat (RWS)	Government
ILT	Government
NVWA	Government

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Appendix 2 Authorised biocidal products in the Netherlands

Appendix 2 Authorised biocidal products in the Netherlands

Reference dates:
- Ctgb database d.d. 04-06-2025
- ECHA database d.d. 28-04-2025

Product name	Number of identical authorisations	Active substance(s)	Use	Authorisation holder	Organisms
Cypermethrin					
Active					
FREE LAND DUST	5	cypermethrin	Both	Activa S.r.l	Road ant, Crawling insects, German cockroach, Oriental cockroach, Wasp, wasp nests
Alpha-cypermethrin					
Active					
Fendona 1.5 SC, Pamova 1.5 SC	2	alfa-cypermethrin	*Both*	BASF Nederland B.V.	Ants, Mosquitos, Stable fly, Housefly, Wasp, German cockroach
Fendona 6 SC, FENDONA, PAMOVA, No Fly	2	alfa-cypermethrin	*Both*	BASF Nederland B.V.	German cockroach, Road ant, Mosquitos, Wasp
Cancelled/expired					
No Fly	*1*	*alfa-cypermethrin*	*Professional*	*BASF Nederland B.V.*	*Crawling insects, Flies*
Deltamethrin					
Active					
Aqua K-Othrine	2	deltamethrin	Professional	2022 Environmental Science FR SAS	Mosquitos
Baythion DELTAMETHRIN DP 0.05	2	deltamethrin	Non-professional	Bayer CropScience S.A.-N.V.	Road ant, Crawling insects, Woodlice
Baythion KO Vloeibaar / Fastion KO Vloeibaar	1	deltamethrin	Non-professional	Bayer CropScience S.A.-N.V.	Road ant
Baythion KO, Fastion KO Poeder, Vermigon Mierenpoeder, HGX Mierenpoeder	2	deltamethrin	Non-professional	Bayer CropScience S.A.-N.V.	Road ant, Crawling insects, Woodlice
Deltacaps 2.5 CS, Resoluut Insectenmiddel Prof, Knock Off Insectenmiddel	2	deltamethrin	Both	Sharda Europe bvba	German cockroach, Oriental cockroach
Deltasect, Delta SC, Vermigon Vloeibaar, Vermigon PRO SC 2.5	4	deltamethrin	Both	Sharda Cropchem Espana S.L.	Cockroach, Ants, Common wasp, Housefly
Detrans Deltamethrin / Baythion Spray / SBM mieren en kruipende insectenspray / Protect kruipende insectenspray / Protect Home mieren en kruipende insectenspray / Dr. Care – Kruipende Insecten spray / Spray Insectes Rampants	1	deltamethrin	Non-professional	Sumitomo Chemical Agro Europe S.A.S.	German cockroach, American cockroach, Ants
KILLMETHRIN 2.5 WP	2	deltamethrin	Both	Sharda Europe bvba	Oriental cockroach
K-Othrine Flexx / K-Othrine Partix	5	deltamethrin	Professional	2022 Environmental Science FR SAS	Bed bug, Crawling insects, German cockroach, American cockroach, Spiders, Housefly Wasp nests
K-Othrine Insect Spray	1	deltamethrin	Non-professional	Bayer CropScience S.A.-N.V.	Crawling insects, Silverfish, Road ant, Cockroach, Woodlice

K-Othrine Insect Spray Deltamethrin EW 0.15	1	deltamethrin	Non-professional	Bayer CropScience S.A.-N.V.	Crawling insects, Road ant, Woodlice, Cockroach, Silverfish
K-Othrine SC7.5	3	deltamethrin	Professional	2022 Environmental Science FR SAS	Crawling insects, Cockroach, Housefly
proteo ec green / PROTEO EC / MASSOCIDE EC / DELTASECT 2,5% EC / DELTAMASTER EC / DELTAFORCE EC / DELTAPLUS EC / DELTAEFFECT EC / DELTAPERFECT EC / DELTAPOWER EC / MAX CRAWL	1	deltamethrin	Professional	Sharda Cropchem Espana S.L.	Oriental cockroach
Pyregon Spray	2	Chrysanthemum cinerariaefolium, extract van bloeiende en volgroeide bloemen van Tanacetum cinerariifolium verkregen met superkritische koolstofdioxide, deltamethrin	Both	Denka Registrations B.V.	Crawling insects, Wasp nests
SOMI / Resoluut Insectenpoeder / Knock Off Insectenpoeder / Luxan Ongediertepoeder / Vermigon PRO DP 0.05 / Deltalux Mierenpoeder / Roxasect ANTI-MIEREN poeder / Kruidvat Mierenpoeder tegen mieren /Knock Off Insectenpoeder / Trekpleister Mierenpoeder tegen mieren	2	deltamethrin	Both	Sharda Cropchem Espana S.L.	Spiders, Cockroach, Ants, Bed bugs
TravelSafe Tropical Pyramid Mosquito net, TravelSafeTropical Box Mosquito net, TravelSafeTropical Wilderness Mosquito net, TravelSafe Tropical Multi style Mosquito net, TravelSafe Tropical Cocoon Mosquito net, TravelSafeTropical Cube Mosquito net, TravelSafeTropical Pop-out Mosquito net, TravelSafe Insect Repellent net	1	deltamethrin	Non-professional	Van Bergen Sports International B.V.	Anopheles Mosquitos
Vapona Antimierenpoeder / Citin Mierenpoeder / Vapona Mierenpoeder	2	deltamethrin	Non-professional	Henkel Nederland B.V.	Road ant, Crawling insects, Woodlice
Zero Insect Spray	2	Chrysanthemum cinerariaefolium, extract van bloeiende en volgroeide bloemen van Tanacetum cinerariifolium verkregen met superkritische koolstofdioxide, deltamethrin	Both	Denka Registrations B.V.	Crawling insects, Wasp nests
Cancelled/expired					
Baythion K.O.	*1*	*deltamethrin*	*Non-professional*	*Bayer CropScience S.A.-N.V.*	*Ants*
HG X tegen wespen	*1*	*deltamethrin*	*Non-professional*	*HG International B.V.*	*Wasps*
HGX Mierenpoeder	*1*	*deltamethrin*	*Non-professional*	*HG International B.V.*	*Ants*
K-Othrine WG250	*1*	*deltamethrin*	*Professional*	*2022 Environmental Science FR SAS*	*Flying insects, Crawling insects*

Ongediertedood	*1*	*deltamethrin*	*Professional*	*Denka Registrations B.V.*	*Crawling insects, Flies*
Vapona Antimierenpoeder	*1*	*deltamethrin*	*Non-professional*	*Henkel Nederland B.V.*	*Ants*
Vermigon Mierenpoeder	*1*	*deltamethrin*	*Non-professional*	*Edialux Nederland B.V.*	*Ants*
Wespenpoeder	*1*	*deltamethrin*	*Professional*	*Denka Registrations B.V.*	*Wasps*
Wespenpoeder N	*1*	*deltamethrin*	*Non-professional*	*Denka Registrations B.V.*	*Wasps*
Imidacloprid					
Active					
DX3 GEL, SKULD GEL LOKDOOS, Imidalux Mierenlokdoos, Vazor Mierenlokdoos, KAPTER MIEREN GEL LOKDOOS, SKULD MIEREN GEL, IMITEC MIEREN GEL, Imidalux Mierengel, DX3 GEL LOKDOOS, KAPTER MIEREN GEL, KAMAZIL MIEREN GEL, Roxasect Mierenloktoren, Knock Off Mierenlokdoos, DX3 MIEREN GEL, KAMAZIL GEL LOKDOOS, KELT MIEREN GEL LOKDOOS, Knock Off Mieren Gel, KELT MIEREN GEL, IMITEC GEL LOKDOOS, Resoluut Mieren Gel, Effect Mier Lokdoos, Mieren Gel Lokdoos Imd, Fourmi'K, Imisect, Fourmix, Mierenbox Imida, Imida-Mier, Knock Pest Mierenlokdoos, Knock Pest Mieren Gel	2	imidacloprid	Both	Zapi S.p.A.	Road ant, Argentine ant, Pharaoh ant
HG mierenlokdoos / Piron Pushbox / HG boîte anti-fourmis / HG Ameisen-Köderbox	1	imidacloprid	Non-professional	SBM Développement	Ants, Road ant, Ghost ant, Pharaoh ant, Argentine ant
IMIDASECT ANTS/ HOMEGARD MIEREN LOKDOOS/ HOMEGARD MIEREN GEL	2	imidacloprid	Both	Sharda Cropchem Espana S.L.	Argentine ant, Pharaoh ant, Road ant
IMIDASECT/HOMEGARD KAKKERLAKKEN LOKDOOS/HOMEGARD KAKKERLAKKEN GEL/CUCARACHA KAKKERLAKKEN LOKDOOS	4	imidacloprid	Both	Sharda Cropchem Espana S.L.	Oriental cockroach, German cockroach
Maxforce pushbox / Maxforce Quantum Bait Station	1*	imidacloprid	Professional	2022 Environmental Science FR SAS	Ants, Road ant, Ghost ant, Pharaoh ant, Argentine ant
Maxforce prime	1	imidacloprid	Professional	2022 Environmental Science FR SAS	German cockroach, Oriental cockroach, American cockroach, Brown-banded cockroach
Maxforce Quantum	2	imidacloprid	Professional	2022 Environmental Science FR SAS	Ghost ant, Pharaoh ant Road ant
Maxforce White IC	1	imidacloprid	Professional	2022 Environmental Science FR SAS	Cockroach, German cockroach, American cockroach, Oriental cockroach, Brown-banded cockroach
Piron Mierenlokdoos/Pokon Mieren STOP lokdoos/HGX Mierenlokdoos/Finion Mierenlokdoos	1	imidacloprid	Non-professional	SBM Développement	Ants
SOFAST	4	cis-tricos-9-een, imidacloprid	Professional	Sharda Cropchem Espana S.L.	Flies, Stable fly
SOJET / PROFI FLY BAIT / FLYKILL 10 WG / Resoluut Vliegendood Strijkmiddel	1	cis-tricos-9-een, imidacloprid	Professional	Sharda Cropchem Espana S.L.	Flies
Cancelled/expired					

Aeroxon Raamsticker tegen Vliegen/ Aeroxon Venstersticker tegen Vliegen/ Roxasect Raamsticker tegen Vliegen/ PIC Raamsticker tegen Vliegen / Insect Protect Venstersticker tegen vliegen / Dr. Care Venstersticker Tegen Vliegen / TI-TOX Venstersticker Tegen Vliegen	*1*	*imidacloprid*	*Non-professional*	*Fr. Kaiser GmbH*	*Housefly*
Bayer kakkerlakken lokdoos / SBM Kakkerlakken lokdoos	*1*	*imidacloprid*	*Non-professional*	*SBM Développement*	*Cockroach*
Bayer Piron Mierenlokdoos	*2*	*imidacloprid*	*Both*	*Bayer CropScience S.A.-N.V.*	*Ants*
Bayer Vliegensticker	*2*	*cis-tricos-9-een, imidacloprid*	*Non-professional*	*Bayer CropScience S.A.-N.V.*	*Flies*
Baythion Mierenmiddel N	*2*	*imidacloprid*	*Both*	*Bayer CropScience S.A.-N.V.*	*Ants*
Finion Mierenlokdoos	*2*	*imidacloprid*	*Non-professional*	*Beaphar B.V.*	*Ants*
HGX korrels tegen mieren	*2*	*imidacloprid*	*Non-professional*	*HG International B.V.*	*Ants*
HGX mierenlokdoos	*2*	*imidacloprid*	*Non-professional*	*HG International B.V.*	*Ants*
LURECTRON Flybait (NL-0018563-0000)	*1*	*cis-tricos-9-een, imidacloprid*	*Professional*	*Denka Registrations B.V.*	*Housefly*
LURECTRON Flybait (13160)	*1*	*cis-tricos-9-een, imidacloprid*	*Professional*	*Denka Registrations B.V.*	*Flies*
Maxforce LN	*2*	*imidacloprid*	*Professional*	*Bayer CropScience S.A.-N.V.*	*Ants*
Maxforce LN Mierenlokdoos (13073)	*2*	*imidacloprid*	*Professional*	*Bayer CropScience S.A.-N.V.*	*Ants*
Maxforce LN Mierenlokdoos (NL-0010722-0000)	*2*	*imidacloprid*	*Both*	*2022 Environmental Science FR SAS*	*Road ant*
Maxforce Quantum	*1*	*imidacloprid*	*Professional*	*Ministerie van Infrastructuur en Waterstaat****	*Tapinoma nigerrimum*
Mieren Stop	*2*	*imidacloprid*	*Both*	*Beaphar B.V.*	*Ants*
MS VB-08	*1*	*cis-tricos-9-een, imidacloprid*	*Professional*	*Bayer CropScience S.A.-N.V.*	*Flies*
Piron Mierenlokdoos	*2*	*imidacloprid*	*Non-professional*	*Bayer CropScience S.A.-N.V.*	*Ants*
Piron mierenmiddel	*2*	*imidacloprid*	*Non-professional*	*Bayer CropScience S.A.-N.V.*	*Ants*
Piron Pushbox	*1*	*imidacloprid*	*Non-professional*	*Bayer CropScience S.A.-N.V.*	*Ants*
POKON mieren	*2*	*imidacloprid*	*Non-professional*	*Pokon Nederland B.V.*	*Ants*
Pokon Mieren STOP Lokdoos	*1*	*imidacloprid*	*Non-professional*	*Pokon Nederland B.V.*	*Ants*
Quick Bait WG10 / Quick Bait WG	*1***	*cis-tricos-9-een, imidacloprid*	*Professional*	*2022 Environmental Science FR SAS*	*Housefly*
Roxasect Mierenlokdoos	*1*	*imidacloprid*	*Non-professional*	*Vemedia B.V.*	*Ants*
ROXASECT RAAMSTICKER	*1*	*imidacloprid*	*Non-professional*	*Bio-Logix Laboratories Ltd.*	*Flies*
Roxasect tegen Tuinmieren	*2*	*imidacloprid*	*Non-professional*	*Vemedia B.V.*	*Ants*

VAPONA Raamsticker	*1*	*cis-tricos-9-een, imidacloprid*	*Non-professional*	*Henkel Nederland B.V.*	*Flies*
Lambda-cyhalothrin					
Active					
Icon 10CS / DEMAND 10CS	1	lambda-cyhalothrin	Professional	Syngenta Crop Protection AG	Housefly, Stable fly
Mirazyl Gran / Demand Granules / Dr. Care Anti Mier Fourmis / Kruidvat Anti-Mieren poeder / Trekpleister Anti-Mieren poeder	1	lambda-cyhalothrin	Both	COMPO Benelux N.V.	Road ant
Cancelled/expired					
Mirazyl Spray Anti-Mieren / Mieren-Stop / Compo Mieren-Stop / Compo Mierenspray / Barriere Insect Mierenspray / Demand Spray	*2*	*lambda-cyhalothrin*	*Non-professional*	*COMPO Benelux N.V.*	*Silverfish, Woodlice, Cockroach, Ants*

* Authorization expired on 08-01-2025
** Authorization expired on 07-04-2025
*** This concerns an emergency authorization: “Vrijstelling Maxforce Quantum Mediterraan draaigatje 2021” (see: https://ctgb-documents-prd-eu-central-1-129851440513.s3.eu-central-1.amazonaws.com/8330f3a4f649acc2fbf4185fd9d6befe_20210375_stcrt-2021-10635+Maxforce+Quantum+BESL.pdf)

About Antea Group

Antea Group is home to 1800 proud engineers and consultants. Together we build a safe, healthy and future-proof living environment every day. With us you will find the very best specialists in the Netherlands, but also innovative solutions in the field of data, sensoring and IT. In this way we contribute to the development of infrastructure, residential areas or water works. But also issues surrounding climate adaptation, energy transition and the replacement task. From research to design, from realization to management: we bring the right knowledge to the table for every assignment. We think critically and always from the mindset of going for the best results together. In this way, we anticipate today's questions and tomorrow's solutions. For 70 years.

INOGEN ALLIANCE

Contact information

Zutphenseweg 31D
7418 AH Deventer
P O box 321
7400 AH Deventer

www.anteagroup.nl