

Insecticides and biodiversity

Prof. dr. Marcel Dicke
Laboratory of Entomology
Wageningen University



1



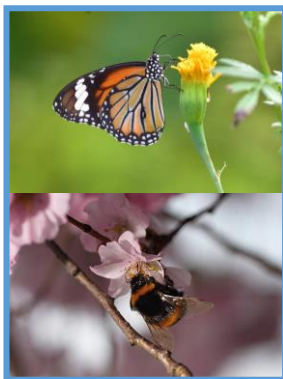
2

Systemic insecticides

- Widely used
- Reach nectar and pollen
- Nectar feeders are harmed
- Similar to calendar spraying



3



4

Nectar is limited because the majority of crops:

- 1) Do not have nectar or are harvested before flowering period
- 2) Flowering period is brief
- 3) Flowers are scarce in field margins



5

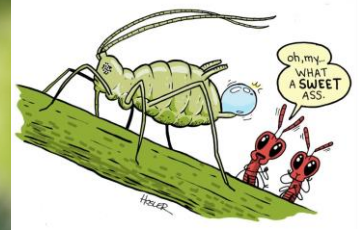
Honeydew is the most abundant and accessible carbohydrate source for beneficial insects in agroecosystems



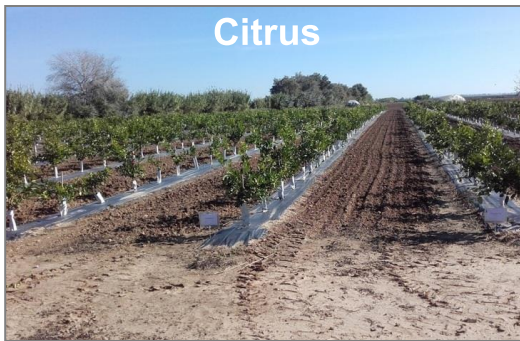
6

Honeydew

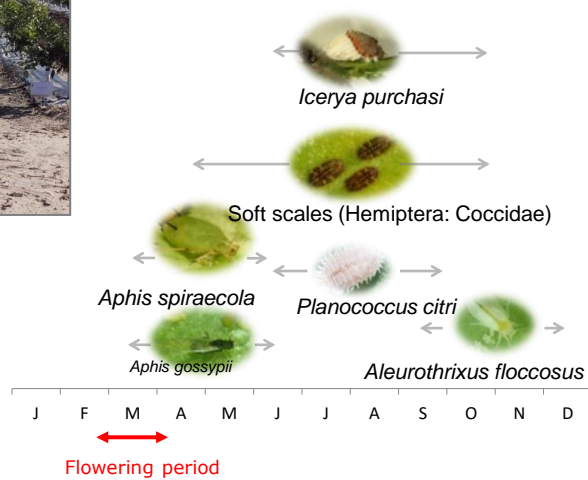
Sugar-rich excretion product of mealybugs, aphids, or whiteflies



7



Citrus

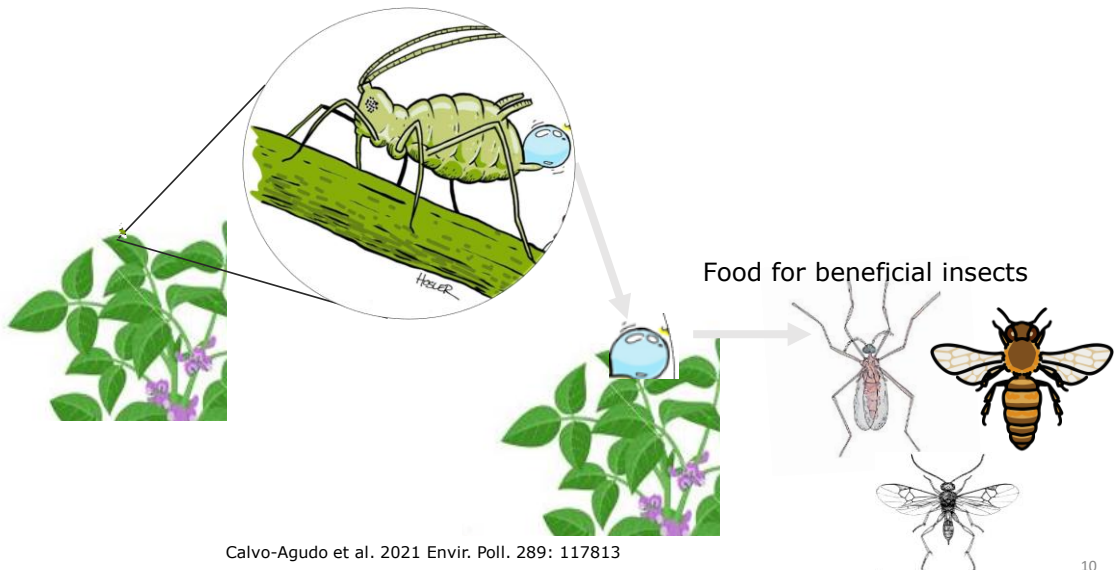


8



9

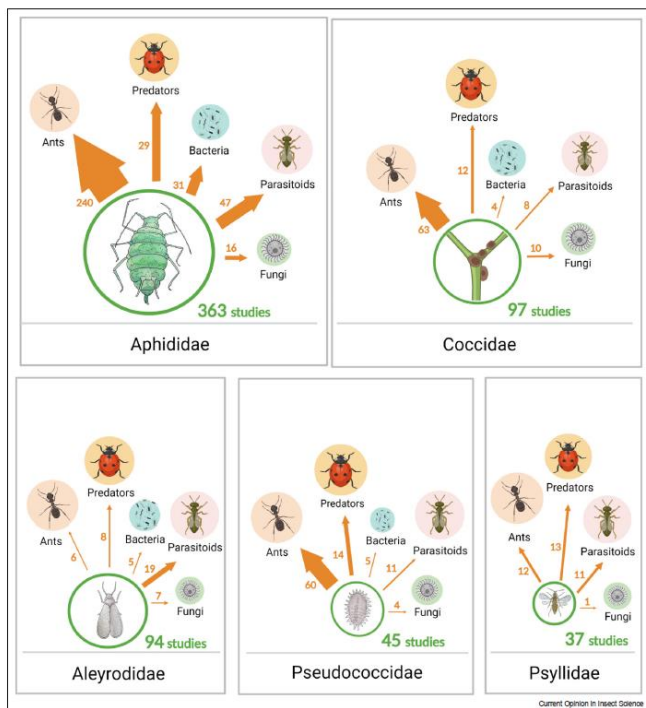
Aphids feed on high-sugar plant sap and poop out the sugar fraction



10

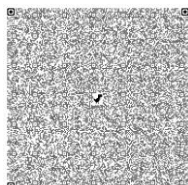
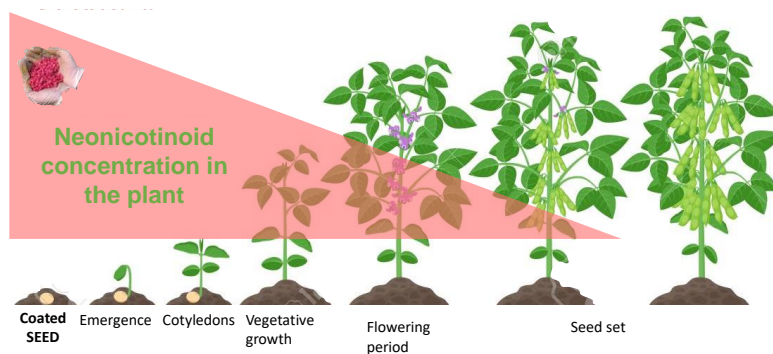
Honeydew is food source for a diversity of organisms

Fernandez de Bobadilla et al Curr. Op. Insect Sci. 61:101151 - 2024



11

Degradation of insecticides upon seed coating

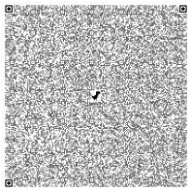
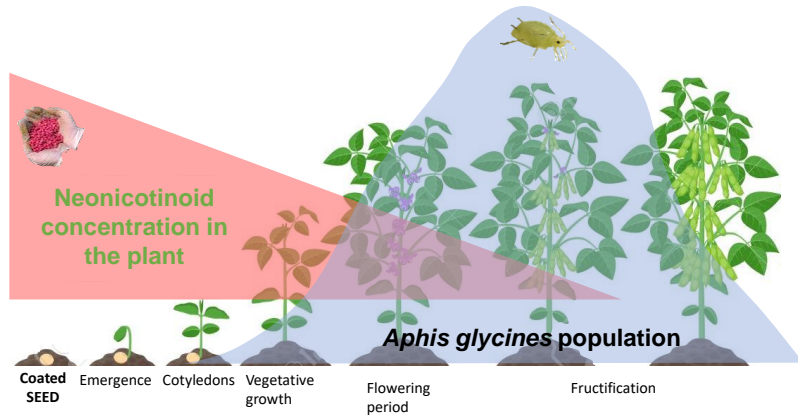


Calvo-Agudo et al. 2021. Environmental Pollution 289: 117813



12

Degradation of insecticides upon seed coating

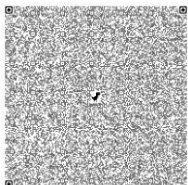
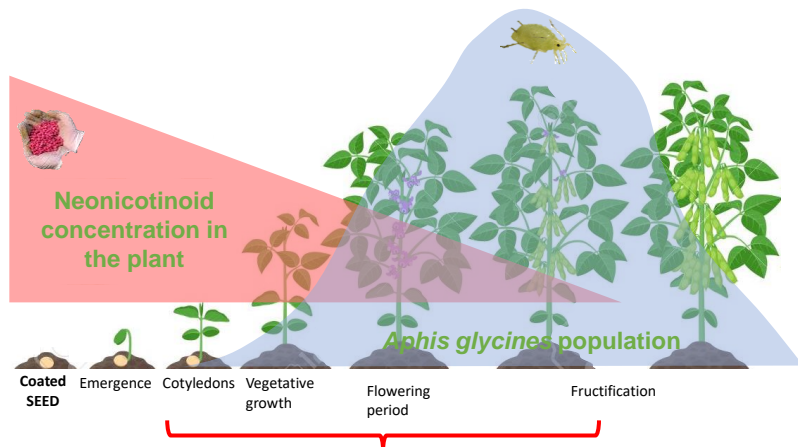


Calvo-Agudo et al. 2021. Environmental Pollution 289: 117813



13

Degradation of insecticides upon seed coating



Does *Aphis glycines* excrete honeydew contaminated with insecticides?

Calvo-Agudo et al. 2021. Environmental Pollution 289: 117813



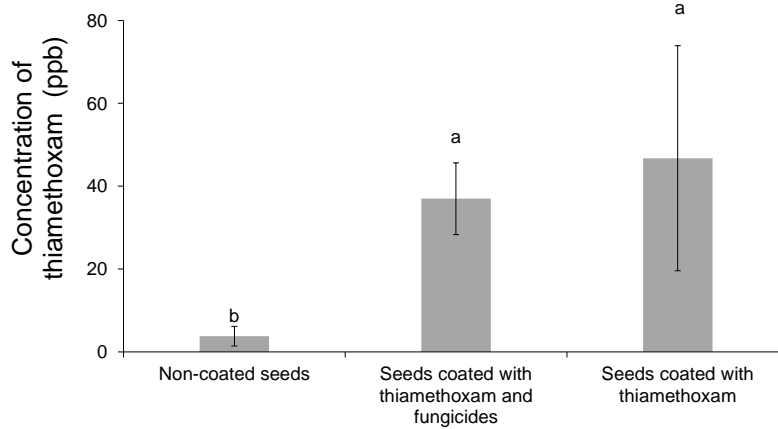
14



Pictures © Miguel Calvo Agudo



15

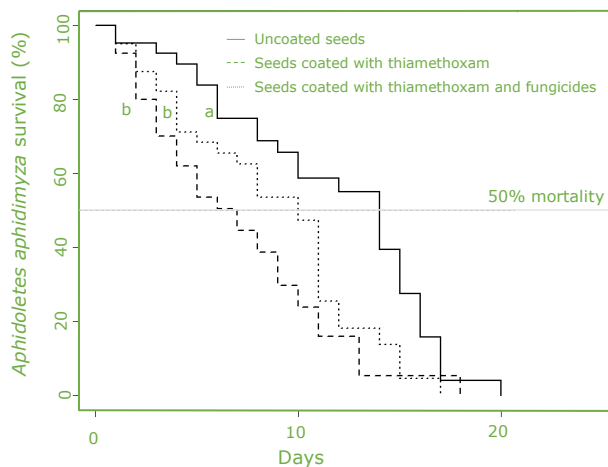
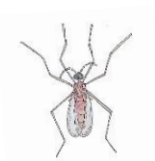


- Thiamethoxam was detected in honeydew excreted by aphids
- The concentrations found were similar to those found in nectar in other studies

Calvo Agudo et al 2021 Environmental Pollution 289: 117813



16



Honeydew contaminated with neonicotinoids reduced the longevity of the predator and a parasitic wasp

Calvo Agudo et al 2021 Environmental Pollution 289: 117813



17

presence of contaminated honeydew that affects biocontrol agents demonstrated for:

- 2 crops
- 4 systemic insecticides
- 3 modes of application
- 3 honeydew producers
- 5 beneficial insects

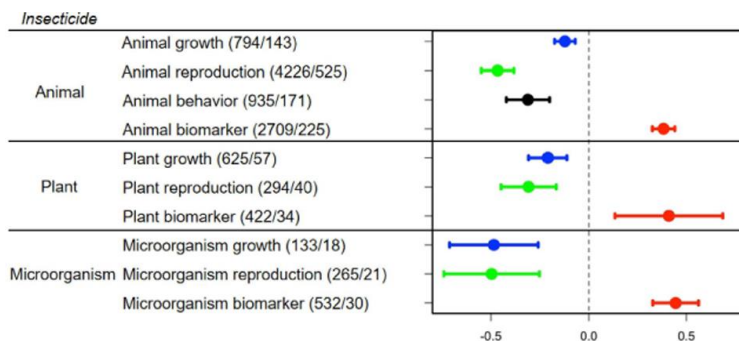


Calvo-Agudo, Tooker, Dicke & Tena 2022. Biological Reviews 97: 664-678



18

Meta-analysis biocides and non-target effects

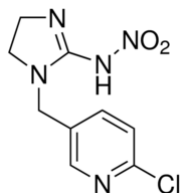


Insecticides

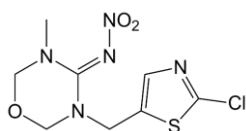
Negatively affect:

- Animals (invertebrates and vertebrates)
- Plants
- Microorganisms

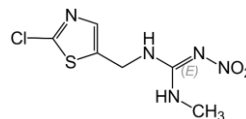
Neonicotinoids



imidacloprid

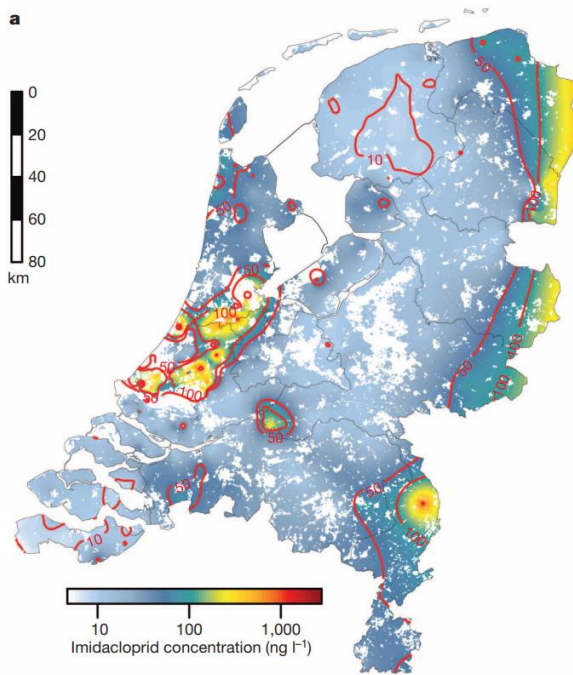


thiamethoxam



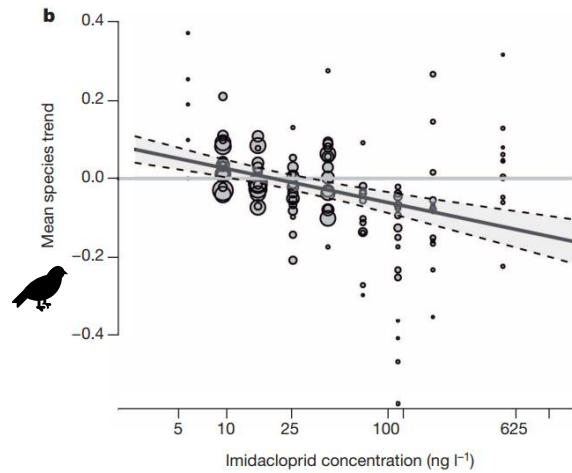
clothianidine

Are they safe for vertebrates?



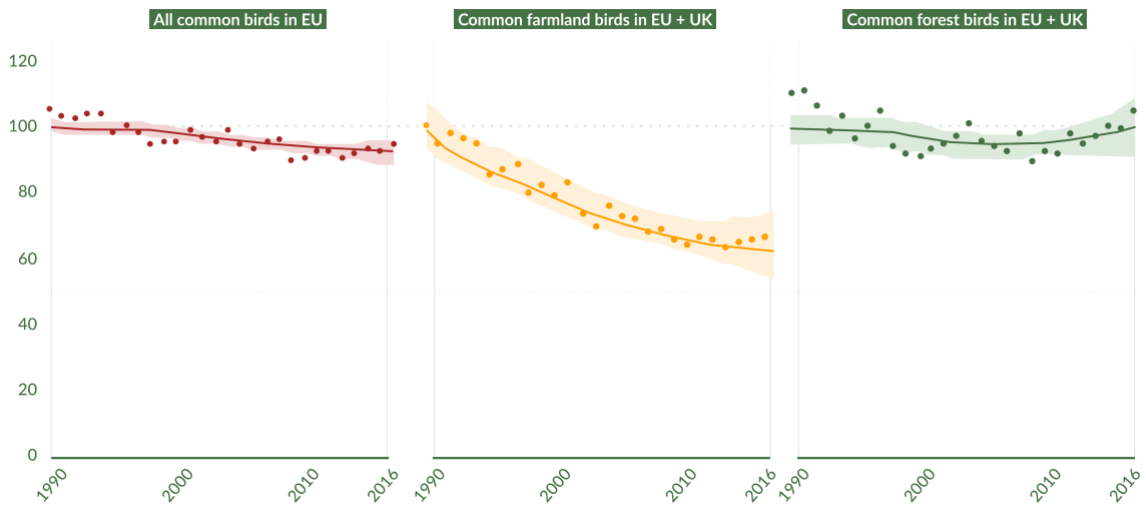
Declines in insectivorous birds are associated with high neonicotinoid concentrations

Caspar A. Hallmann^{1,2}, Ruud P. B. Foppen^{3,4}, Chris A. M. van Turnhout², Hans de Kroon¹ & Eelke Jongejans¹



Hallmann et al. Nature 2014

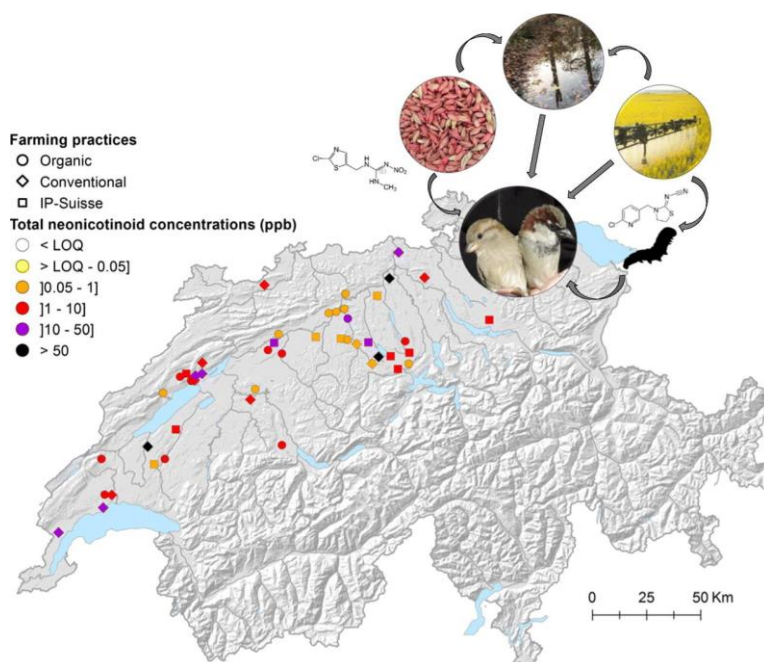
21



European Environment Agency 2020

22

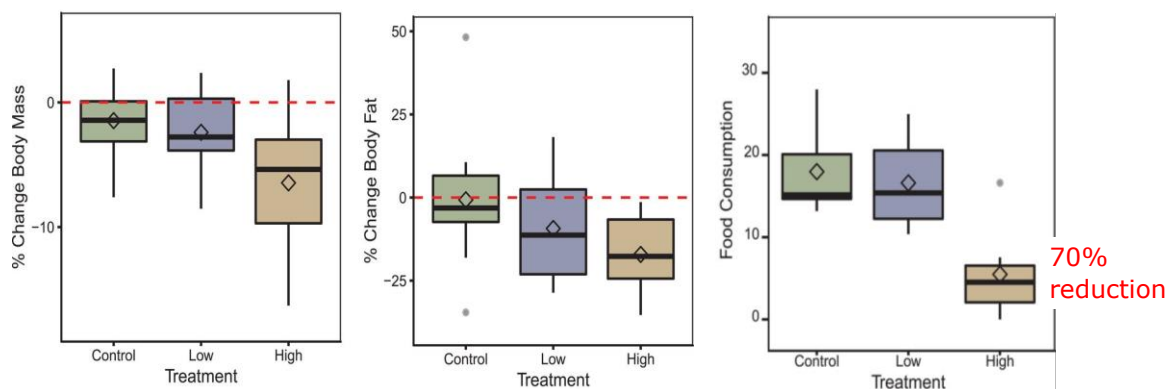
Neonicotinoids in feathers of house sparrow



Science of The Total Environment 660, 1091-1097 (2019)

23

White-crowned sparrow: imidacloprid



Eng et al. 2019 Science



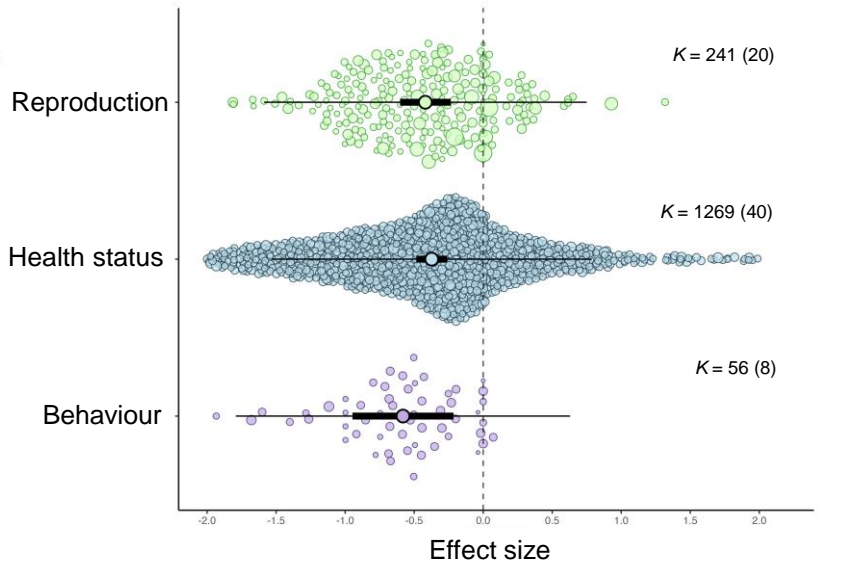
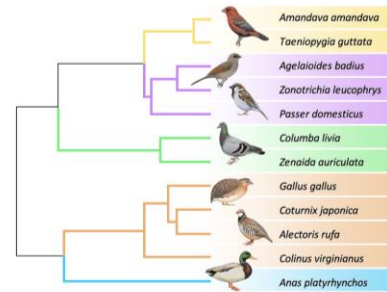
SYNTHESIS

Neonicotinoids Impact All Aspects of Bird Life: A Meta-Analysis

Elke Molenaar¹ | Wolfgang Vrethaus² | Jansko van de Crommenacker³ | Sjoke A. Kingma⁴

¹Behavioral Ecology Group, Department of Animal Sciences, Wageningen University and Research, Wageningen, The Netherlands | ²Department of Psychiatry and Neuroendocrinology, School for Mental Health and Neuroscience, Maastricht University, Maastricht, The Netherlands | ³Vogelbescherming Nederland, Zeist, The Netherlands

Correspondence: Elke Molenaar (elke.molenaar@wur.nl) | Sjoke A. Kingma (sjoke.kingma@wur.nl)

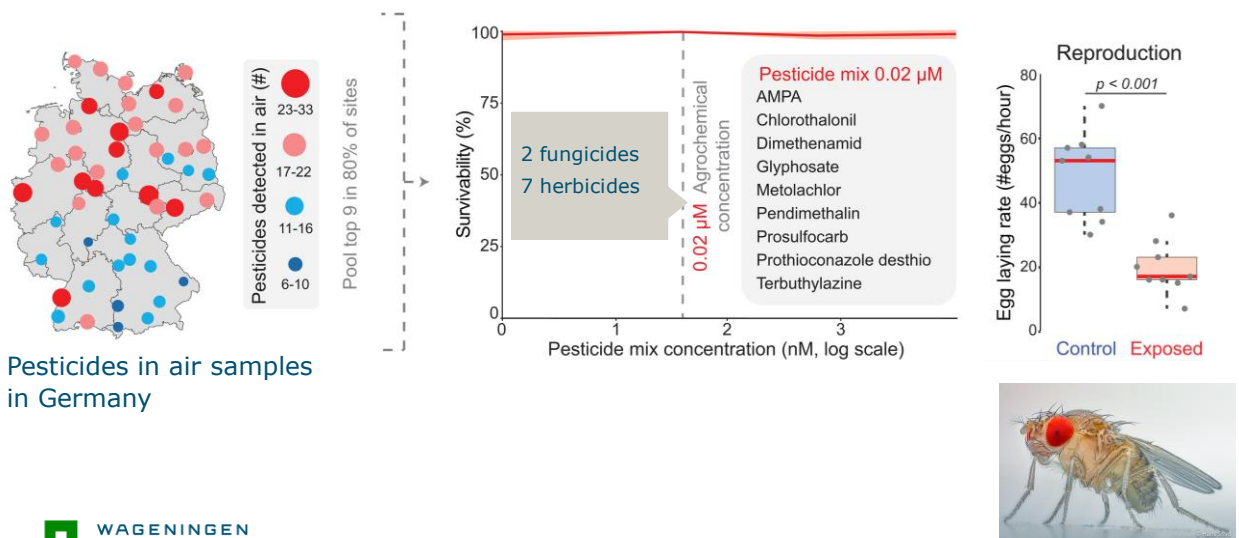


Molenaar et al. Ecol. Lett. 2024

25

Mixtures of pesticides

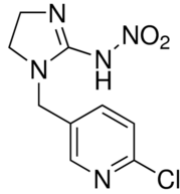
cocktail of 7 common fungicides and herbicides affect insect reproduction



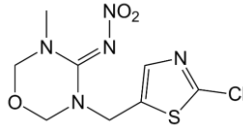
Gandara et al. 2024 Science

26

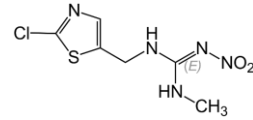
Neonicotinoids



imidacloprid



thiamethoxam



clothianidine

Are they safe for humans?

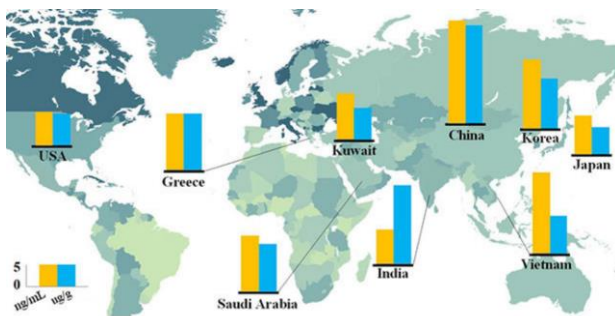


27

Environ Int. 2020 December ; 145: 106120. doi:10.1016/j.envint.2020.106120.

Profiles of urinary neonicotinoids and dialkylphosphates in populations in nine countries

Adela Jing Li^a, Kurunthachalam Kannan^{a,b,*}



Yellow = neonicotinoids
Blue: organophosphates

28



RESEARCH

Open Access



Multiple neonicotinoids in children's cerebro-spinal fluid, plasma, and urine

Bernard Laubscher^{1*}, Manuel Diezi^{2†}, Raffaele Renella², Edward A. D. Mitchell³, Alexandre Aebi⁴, Matthieu Mulot⁵ and Gaëtan Glauser²

Abstract

Background: Neonicotinoids (NN) are selective neurotoxic pesticides that bind to insect but also mammal nicotinic acetylcholine receptors (nAChRs). As the most widely used class of insecticides worldwide, they are ubiquitously found in the environment, wildlife, and foods, and thus of special concern for their impacts on the environment and human health. nAChRs are vital to proper brain organization during the prenatal period and play important roles in various motor, emotional, and cognitive functions. Little is known on children's contamination by NN. In a pilot study we tested the hypothesis that children's cerebro-spinal fluid (CSF) can be contaminated by NN.

Methods: NN were analysed in leftover CSF, blood, and urine samples from children treated for leukaemias and lymphomas and undergoing therapeutic lumbar punctions. We monitored all neonicotinoids approved on the global market and some of their most common metabolites by ultra-high performance liquid chromatography-tandem mass spectrometry.

Conclusions: We have developed a reliable analytical method that revealed multiple NN and/or their metabolites in children's CSF, plasma, and urine. Our data suggest that contamination by multiple NN is not only an environmental hazard for non-target insects such as bees but also potentially for children.

Keywords: Neonicotinoid, *N*-desmethyl-acetamiprid, Pesticide, Child, Cerebro-spinal fluid

Keywords: Neonicotinoid, *N*-desmethyl-acetamiprid, Pesticide, Child, Cerebro-spinal fluid

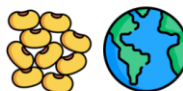
29

“Pesticides are needed to feed the world”

- Organic agriculture has ca 10-20% lower yield
- But 70% of total agricultural area used for meat production

Production for Feed

- 76% of global **soy** production



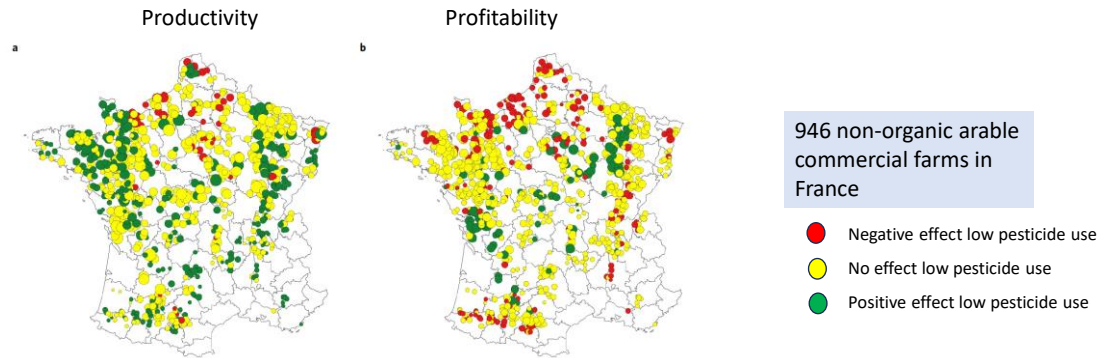
- 75-80% of EU **corn** production



- 40-50% of EU **wheat** production



30



- 77%: no conflict between low pesticide use and both high productivity and high profitability
- total pesticide use could be reduced by 42% without any negative effects on both productivity and profitability in 59% of farms from our national network
- Tailor-made solutions with major opportunities

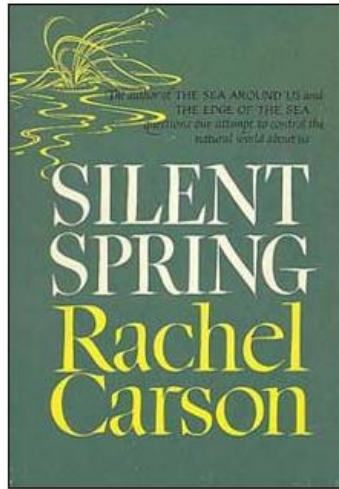
Lechenet et al. 2017 Nature Plants

31

So ... why do we use pesticides in food production?

32

27 sept 1962



“Future historians may well be amazed by our distorted sense of proportion. How could intelligent beings seek to control a few unwanted species by a method that contaminated the entire environment and brought the threat of disease and death even to their own kind?”