WILL THE USE OF NEONICOTINOIDS IN GREENHOUSES CONTINUE TO PRESENT A RISK FOR BEES AND OTHER ORGANISMS?

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GREENPEACE

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1.0 INTRODUCTION

The European Commission has proposed a ban on three neonicotinoids – imidacloprid, clothianidin and thiamethoxam (referred to as neonicotinoids hereafter) – on all crops with the exception of crops grown in permanent greenhouses, *"where the crop stays its entire life cycle within the greenhouse and is thus not replanted outside"*.[1]

According to the European Food Safety Authority (EFSA), the definition of 'uses in permanent greenhouses' is as follows: *crops/plants grown in a permanent walk-in, static, closed place for crop production with a non-permeable translucent outer shell.*[2]

EFSA concluded that foliar uses of these three neonicotinoid substances[2, 3, 4] in greenhouses constituted a *"low risk to honeybees, bumble bees and solitary bees"* for all exposure routes with the exception of exposure of honeybees from residues in surface water which EFSA could not assess, due to a lack of information.[2] EFSA considered that no risk assessment was required for uses as seed treatment and granules in greenhouses.[5, 6]

The aim of this review is to bring together literature on the uses of neonicotinoids in greenhouses throughout the European Union and assess current knowledge on the potential exposure of bees and other organisms. There is already an existing body of literature that describes the impacts of exposure to neonicotinoids for bees, honeybees and many other organisms.[7, 8] The purpose of this report is to focus specifically on the use of neonicotinoids in greenhouses and is not intended to replicate, or review, literature on specific evidence on impacts of exposure.

1 Draft Commission Implementing Regulations amending Implementing Regulation (EU) 540/2011 as regards the conditions of approval of the active substances imidacloprid, clothianidin, thiamethoxam.

2 European Food Safety Authority. (2015). Conclusion on the peer review of the pesticide risk assessment for bees for the active substance imidacloprid considering all uses other than seed treatments and granules. EFSA Journal 13: 4211. doi: 10.2903/j.efsa.2015.4211

3 European Food Safety Authority. (2015). Conclusion on the peer review of the pesticide risk assessment for bees for the active substance clothianidin considering all uses other than seed treatments and granules. EFSA Journal 13: 4210. doi: 10.2903/j.efsa.2015.4210

4 European Food Safety Authority. (2015). Conclusion on the peer review of the pesticide risk assessment for bees for the active substance thiamethoxam considering all uses other than seed treatments and granules. EFSA Journal 13: 4212. doi:10.2903/j.efsa.2015.4212

5 European Food Safety Authority. (2016). Conclusion on the peer review of the pesticide risk assessment for the active substance clothianidin in light of confirmatory data submitted. EFSA Journal 14: 4606. doi:10.2903/j.efsa.2016.4606

6 European Food Safety Authority. (2016). Conclusion on the peer review of the pesticide risk assessment for the active substance imidacloprid in light of confirmatory data submitted. EFSA Journal 14: 4607. doi:10.2903/j.efsa.2016.4607

7 Pisa, L. et al. (2017). An update of the Worldwide Integrated Assessment (WIA) on systemic insecticides. Part 2: impacts on organisms and ecosystems. Environmental Science and Pollution Research. doi.10.1007/s11356-017-0341-3

8 Wood, T.J., Goulson, D. (2017). The environmental risks of neonicotinoid pesticides: a review of the evidence post 2013. Environmental Science and Pollution Research 24: 17285-17325. doi. 10.1007/s11356-017-9240-x

2.0 CURRENT PATTERNS OF NEONICOTINOID PESTICIDE USE ON CROPS GROWN IN GREENHOUSES

Using a definition of "greenhouse crops" to include those grown under permanent glass or plastic structures, with climate controls as necessary, recent European Union official agricultural statistics (2013) show that 114,320 hectares of greenhouses were used to grow vegetables, melons and strawberries, according to Cuesta Roble Consulting (Gary Hickman, Cuesta Roble Consulting, *pers. comm.*). According to Eurostat, tomatoes, carrots and onions were assessed as the most important vegetables in economic terms in 2015.[9]

In Almería in Spain, according to IberianNature.com, the area covered by greenhouses had reached 20,000 hectares in 2000.[10] In 2014, Spain accounted for the largest proportion (19.9%) of the total quantity of pesticide sales across the European Union followed by France (19.0%), Italy (16.2%) and Germany (11.6%).[11]

2.1 CROP TYPES

The growing of crops in greenhouses is considered 'intensive production' and information from Eurostat suggests that these crops include salads, tomatoes and many other vegetables grown under glass in controlled environments. Krueger et al. (2010) describe greenhouse production in Sweden that focuses on cucumbers, tomatoes and ornamental plants.[12]

The large expanses of greenhouses in Almería, Southern Spain, grow mostly tomatoes and imidacloprid appears to be widely applied as a seed dressing and foliar treatment.[13]

Almost all tomatoes in the United Kingdom are grown in greenhouses. Other crops include cucumbers, peppers, lettuce, 'other vegetables' and edible plants for propagation, according to the latest Pesticide Usage Survey Report for Edible Protected Crops harvested in the United Kingdom.[14] The report outlines the pesticides used in growing these crops and cites thiacloprid as the only neonicotinoid.

The British Tomato Growers' Association states that some 2.5 million British native bumblebees

9 *http://ec.europa.eu/eurostat/statistics-explained/index.php/Agricultural_production_-_crops*

10 *http://www.iberianature.com/material/greenhouse_almeria.htm*

11 *http://ec.europa.eu/eurostat/statistics-explained/index.php/Pesticide_sales_statistics*

12 Kreuger, J., Graaf, S., Patring, J., Adielsson, S. (2002). Pesticides in surface water in areas with open ground and greenhouse horticultural crops in Sweden. Swedish University of Agricultural Sciences, Division of Water Quality Management. Ekohydrologi 117. ISSN 0347-9307. 49 pp.

13 González-Pradas, E., Ureña-Amate, M.D., Flores-Céspedes, F., Fernández-Pérez, M., Garratt, J., Wilkins, R., (2002). Leaching of imidacloprid and procymidone in a greenhouse of southeast of Spain. Soil Science Society of America Journal 66:1821-1828.

14 *http://pusstats.fera.defra.gov.uk/surveys/documents/edibleProtected2015v1.pdf*

are used to pollinate all the tomato crops in the United Kingdom.[15] Tomato and pepper flowers are self-pollinating but additional pollination by bumblebee species can result in larger, more attractive fruit.[16, 17] Bumblebees are placed in the greenhouses for up to eight weeks and pollination success depends on the bees producing offspring during that time. Studies have shown that neonicotinoids applied in greenhouses can affect greenhouse bee populations and presumably the efficacy of the pollination services they provide.[18]

According to EFSA, the only currently authorised use of the three neonicotinoids covered by the existing ban in permanent greenhouses is in France for the treatment of maize and sweet maize using granulated clothianidin.[3]

2.2 TYPES OF APPLICATION

Neonicotinoids can be applied as foliar sprays, seed coatings, soil drenches, granules, or by chemigation (additive to irrigation water). Direct injection into tree trunks may also be carried out.[19] Academic literature and more popular focused news articles suggest that, in the past, all types of neonicotinoid treatments have been used in growing crops in greenhouses in Europe.[20] Domenica et al. (2017) specifically state that seed treatments, together with soil and foliar sprays are all permitted for use in greenhouses in the European Union.[21]

Prior to 2012, 70% of neonicotinoids used on fields were applied in the European Union through spraying, 20% as seed treatments and the remainder as drip irrigation, soil disinfectants and other types of treatment, according to EFSA.[22] Godfray et al. (2014) state that, for the United Kingdom, neonicotinoids are most frequently (approximately 90% by volume) applied as seed treatments.[23] This is most likely to be due to the convenience and cost effectiveness of seed treatments, which are taken up systemically by the growing plant.

2.3 LEVEL OF APPLICATION REPORTED

The 2016 EFSA report on the risk of **clothianidin** considers the usage of granules in permanent greenhouses with an application rate of 50 g active substance (a.s.) per hectare.[24] For **imidacloprid,** EFSA considers seed treatments for the production of leafy vegetable seedlings in all types of growing conditions at a rate of 90 g a.s./hectare (0.8 mg a.s./seed) and 120 g a.s./hectare (1.2 mg a.s./seed).[19, 25] The use of imidacloprid in greenhouses in Canada covers all crop types and typical application rates to foliage or soil vary between crops and range from 42 to 480 g a.s./hectare.[26] These levels of application are consistent with that considered by EFSA but Struger et al. (2017) suggest that for fruiting vegetables in Canada, application rates can be as high as 560 g a.s./hectare.[26, 27] In the United States, suggested application rates for imidacloprid are 48.2 g a.s./ha (Admire Pro® 4.6SC).[28] For **thiamethoxam,** U.S. application rates are similar, 52.5 g a.s./ha (Actara® 25WD).[29] For non-specified neonicotinoid application, the findings of Godfray et al. (2014) are consistent with those above in that application rates for maize seeds are estimated at 1.2 mg a.s./seed.[23]

15 *http:// www.britishtomatoes.co.uk*

16 van Ravestijn, W., van der Sande, J. (1991). Use of bumblebees for the pollination of glasshouse tomatoes. Sixth International Symposium on Pollination. Acta Horticulturae 288: 204–209.

17 Shipp, J.L., Whitfield, G.H., Papadopoulos, A.P. (1994). Effectiveness of the bumble bee, Bombus impatiens Cr. (Hymenoptera: Apidae), as a pollinator of greenhouse sweet pepper. Scientia Horticulturae 57: 29–39.

18 Gradish, A.E., Scott Dupree, C.D., Shipp, L., Harris, C.R. and Ferguson, G. (2010). Effect of reduced risk pesticides for use in greenhouse vegetable production on Bombus impatiens (Hymenoptera: Apidae). Pest Management Science 66: 142-146. doi.10.1002/ps.1846

19 EU Parliament (2012). Existing scientific evidence of the effects of neonicotinoid pesticides on bees. http://www.europarl.europa.eu/RegData/etudes/note/join/2012/492465/IPOL-ENVI_NT(2012)492465_EN.pdf

20 *https://www.theguardian.com/world/2005/sep/21/spain.gilestremlett*

21 Domenica, A., Maria, A., Stefania, B., Alessio, I., Alberto, L., Tunde, M., Rachel, S., Csaba, S., Benedicte, V., Alessia, V. (2017). Neonicotinoids and bees: The case of the European regulatory risk assessment. Science of the Total Environment 579: 966-971. doi.10.1016/j.scitotenv.2016.10.158

22 EFSA (2012): Statement on the findings in recent studies investigating sub-lethal effects in bees of some neonicotinoids in consideration of the uses currently authorized in Europe. EFSA Journal 2012 10: 2752. doi. 10.2903/j.efsa.2012.2752

23 Godfray, H.C.J., Blacquière, T., Field, L.M., Hails, R.S., Petrokofsky, G., Potts, S.G., Raine, N.E., Vanbergen, A.J., McLean, A.R. (2014). A restatement of the natural science evidence base concerning neonicotinoid insecticides and insect pollinators. Proceedings of the Royal Society B 281: 20140558. doi. 10.1098/rspb.2014.0558

24 EFSA (2016). Conclusion on the peer review of the pesticide risk assessment for the active substance clothianidin in light of confirmatory data submitted. EFSA Journal 14: 4606 doi:10.2903/j.efsa.2016.4606

25 EFSA (2016). Conclusion on the peer review of the pesticide risk assessment for the active substance imidacloprid in light of confirmatory data submitted. EFSA Journal 2016 14: 4607. 39 pp. doi:10.2903/j.efsa.2016.4607

26 Struger, J., Grabuski, J., Cagampan, S., Sverko, E., McGoldrick, D., Marvin, C.H. (2017). Factors influencing the occurrence and distribution of neonicotinoid insecticides in surface waters of southern Ontario, Canada. Chemosphere 169: 516-523. doi. 10.1016/j.chemosphere.2016.11.036

27 PMRA (2016). Re-evaluation of imidacloprid preliminary pollinator assessment. Re-evaluation note REV2016e05. Health Canada Pest Management Regulatory Agency, Ottawa. ISSN 1925-0630.

28 Bayer CropScience LP, Research Triangle Park, NC, USA.

29 Syngenta Crop Protection, LLC, Greensboro, NC, USA.

2.4 TIMING OF APPLICATION

Neonicotinoids are marketed as providing an instant, early season broad-spectrum pest control.[30] These products are often used throughout the growing season, particularly during fruiting and for preventative purposes in mid-summer.[22] Extreme weather, such as flooding or drought, will affect leaching rates and such confounding factors make estimating the time of application from presence of the substance in the surrounding environment extremely difficult.

Several types of neonicotinoids have been detected in surface waters in many countries throughout the year. According to Struger et al. (2017), who tested for the presence of neonicotinoids in surface waters over a three-year period, the occurrence of imidacloprid in certain study areas exhibited a bimodal distribution with a maximum in late spring and early summer/autumn.[26] This trend was thought to be due to greenhouse and/or vegetable applications where typical application periods are during the spring and autumn.

Clothianidin and imidacloprid are known to be highly soluble and thiamethoxam is classed as moderately soluble.[31] All three substances have been shown to bind to soil particles and organic matter, with imidacloprid binding to sediments with a DT_{50} (disappearance time for 50% residue) known to be slow (at least 129 days).[32] According to the Pesticide Properties Database, typical half-lives for neonicotinoids range from 15–300 days with longer estimates in laboratory and in the field particularly in freezing or in drought conditions. However, some neonicotinoids are known to persist in the environment for over 1000 days.[33] For example, a European Parliament document[19] cite a Xerces Society review of the effects of neonicotinoids on pollinators and reports that clothianidin (which is also a primary metabolite of thiamethoxam) can have a half-life of up to 1155 days in soil and imidacloprid, 997 days in the same conditions.[34] The Xerces report uses current United States Environmental Protection Agency findings.

2.5 TRENDS IN NEONICOTINOID APPLICATION OVER TIME:

BEFORE AND AFTER EUROPEAN UNION RESTRICTIONS

Data on the use of all neonicotinoids specifically for crops grown in greenhouses throughout the EU is difficult to find. In general terms, according to Simon-Delso et al. (2015), trends, sales and use of neonicotinoids increased exponentially throughout the 2000s in Sweden, Japan, California and the UK until the 2012 (Fig. 1).[35] From 2006 – 2012, clothianidin appears to increase in usage throughout the UK as it replaces imidacloprid (Fig. 2) and from 2008 – 2012 thiamethoxam becomes more commonly used.

For all uses, outdoor and in greenhouses, Syngenta appear to have marketed two products in 2011, Actara® and Cruiser® (both containing thiamethoxam), and their current global website suggests that in Europe the only product containing neonicotinoids is Cruiser®. In a press release, dated the 24th April 2017, Syngenta reports a late start to the season in Europe and reduced sales in Northern Europe for all insecticides (i.e. not specifically neonicotinoids).[36] More specific sales figures have been requested from Syngenta but, at the time of writing, no reply had been received and, in general data on sales of pesticides was difficult to obtain.

Other products containing neonicotinoids (i.e. imidacloprid and clothianidin) that were sold in Europe are produced by Bayer. No sales figures were available at the time of publication.

30 *http://www4.syngenta.com/*

31 Bonmatin, J.M., Giorio, C., Girolami, V., Goulson, D., Kreutzweiser, D., Krupke C., Liess, M., Long, E., Marzaro, M., Mitchell, E., Nomme, D., Simon-Delso, N., Tapparo, A. (2015). Environmental Science Pollution Research 22: 35. doi. 10.1007/s11356-014-3332-7

32 PPDB (2012) Pesticide Properties Database. *http://sitem.herts.ac.uk/aeru/ppdb/en/index.htm.*

33 van der Sluijs, J.P., Amaral-Rogers, V., Belzunces, L.P. et al. (2015). Conclusions of the Worldwide Integrated Assessment on the risks of neonicotinoids and fipronil to biodiversity. Environmental Science and Pollution Research 22: 148. doi. 10.1007/s11356-014-3229-5

34 Hopwood, J., Vaughn, M., Shepherd, M., Biddinger, D., Mader, E., Black, S.H., Mazzacano, C. (2012). Are Neonicotinoids Killing Bees? A Review of Research into the Effects of Neonicotinoid Insecticides on Bees, with Recommendations for Actions. 32pp. The Xerces Society for Invertebrate Conservation.

35 Simon-Delso, N., Amaral-Rogers, V., Belzunces, L.P., Bonmatin, J.M., Chagnon, M., Downs, C., Furlan, L., Gibbons, D.W., Giorio, C., Girolami, V., Goulson, D. (2015). Systemic insecticides (neonicotinoids and fipronil): trends, uses, mode of action and metabolites. Environmental Science and Pollution Research 22: 5-34. doi. 10.1007/s11356-014-3470-y

36 *http://www4.syngenta.com/media/media-releases/yr-2017/24-04-2017*

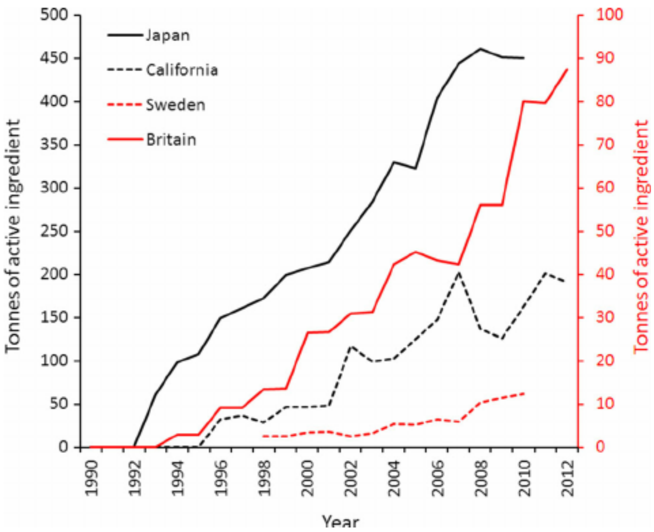

Figure 1. Trend in the sales (Sweden), domestic shipment (Japan), use (California) and agricultural use (Britain) of all neonicotinoid insecticides and fipronil between 1990 and 2012. All measured in tonnes of active ingredient per year. Note the separate vertical axes for California// Japan, and Britain//Sweden. Source: Reproduced under the Creative Commons Attribution Licence from Simon-Delso et al. (2015).[35]

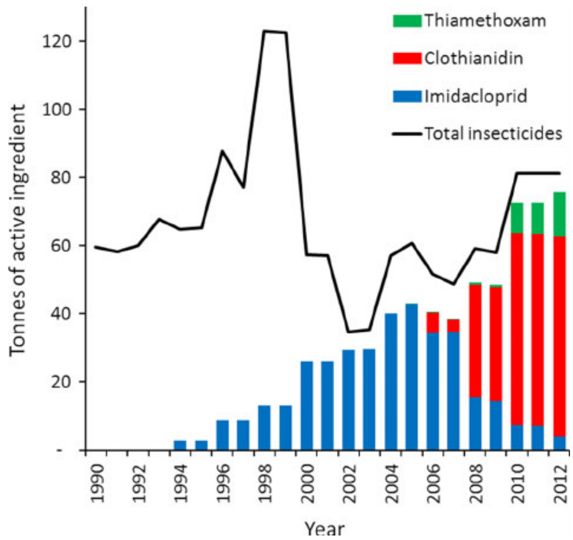

Figure 2. Trend in the agricultural use of neonicotinoid insecticides as seed treatments in Britain between 1990 and 2012, measured in tonnes of active ingredient per year (bars). The total usage of all insecticidal seed treatments (solid line) is also shown.[35] Source: Reproduced under the Creative Commons Attribution Licence from Simon-Delso et al. (2015). Data from *http://pusstats.fera.defra.gov.uk/index.cfm*

3.0 PATHWAYS OF EXPOSURE TO NEONICOTINOIDS FROM USE IN GREENHOUSE

3.1 LEACHING AND WASTEWATER DRAINAGE

Neonicotinoids are frequently found in watercourses where greenhouse crops are grown. Systemic pesticides are often applied to greenhouse food or ornamental crops using chemigation (adding substances to irrigation water). In these cases, wastewater runoff from the treated greenhouses can contain high levels of neonicotinoids.[37]

In 2008, Krueger et al. (2010) sampled run-off water in four areas with outdoor vegetable growing and two greenhouse-growing areas in Sweden.[38] For the 123 substances tested for, the **highest concentrations were found in the two greenhouse areas.** A range of different substances were found in stream water draining areas with greenhouse cultivation and imidacloprid, was the individual substance that most commonly exceeded the guideline value (0.013 gg/l), exceeding it in all samples from the two greenhouse areas.

In the Netherlands, water quality is regularly monitored by the local water authorities and data collated and managed by the Centre for Environmental Sciences at Leiden.[39] Spatial analyses of data on water quality collected by these water authorities show **high levels of pesticide contamination correlating with areas of intensive greenhouse production.** In 2016 exceedances for imidacloprid in surface water are regularly more than 20 times the permitted concentration.[40]

A Canadian study carried out by Struger et al. (2017) tested for the presence of five neonicotinoids (acetamiprid, clothianidin, imidacloprid, thiacloprid and thiamethoxam) at surface water sites in Southern Ontario where a range of agricultural activities were in operation. Sites were sampled over a three-year period (2012-2014). The occurrence and distribution of neonicotinoids in surface waters was influenced by land-use, with the **detection of imidacloprid strongly correlated with greenhouse activity.**[41] The authors suggest that may be due to the ability of imidacloprid to leach into soil and thereby translocate to the outside of the greenhouses or to other factors that involve contamination outside of the greenhouses, i.e. during mixing or storage of these pesticides.

For soil-grown crops, leaching into the soil is likely to be a route of surface water contamination. Gonzales-Prada et al. (2002) tested the ability of imidacloprid to reach soil water down to 40 cm depth, using high dosage applications to represent a 'worst case scenario' and found significant leaching to all depths tests for up to 28 days.[42] The highest levels of imidacloprid were found in layers of sand.

37 Bonmatin, J.M., Giorio, C., Girolami, V., Goulson, D., Kreutzweiser, D.P., Krupke, C., Liess, M., Long, E., Marzaro, M., Mitchell, E.A.D. and Noome, D.A. (2015). Environmental fate and exposure; neonicotinoids and fipronil. Environmental Science and Pollution Research 22: 35-67. doi. 10.1007/s11356-014-3332-7

38 Kreuger J, Graaf S, Patring J, Adielsson S (2010) Pesticides in surface water in areas with open ground and greenhouse horticultural crops in Sweden 2008. pp. 49. *http://pub.epsilon.slu.se/5413/1/kreuger_j_et_al_101014.pdf. Accessed 11th April 2017.*

39 represented in the Bestrijdingsmiddelenatlas, www.bestrijdingsmiddelenatlas.nl

40 Press release *https://www.universiteitleiden.nl/nieuws/2016/07/cml-onverminderd-grote-normoverschrijdingen-van-imidacloprid-in-het-oppervlaktewater* Describes findings of report, Tamis, W., van 't Zelfde, M., Viiver, M. (2016). Analysis of imidacloprid in the surface water up to and including February 2016. University of Leiden, ISBN: 978-90-5191-177-0

41 Struger, J., Grabuski, J., Cagampan, S., Sverko, E., McGoldrick, D., Marvin, C.H. (2017). Factors influencing the occurrence and distribution of neonicotinoid insecticides in surface waters of southern Ontario, Canada. Chemosphere 169: 516-523. doi. 10.1016/j.chemosphere.2016.11.036

42 González-Pradas, E., Ureña-Amate, M.D., Flores-Céspedes, F., Fernández-Pérez, M., Garratt, J., Wilkins, R., (2002). Leaching of imidacloprid and procymidone in a greenhouse of southeast of Spain. Soil Science Society of America Journal 66: 1821-1828.

For crops grown in greenhouses hydroponically, systems are either open (free draining) or closed (with or without waste water recycling). Wastewater recycling is encouraged in best practice guidelines so as to reduce nutrient release to the environment, which is seen as both economically costly and not environmentally sustainable.[43] In all systems, it is suggested that pesticide application is carefully timed in relation to discharging wastewater. This may indicate that in situations where best practices are not adhered to, wastewater is discharged at times that are convenient to the farmer rather than with environmental issues in mind.

In the Westland region of the Netherlands there is a high geographic concentration of greenhouses that have been connected to the sewage system since 2013. In theory, there should be no pesticides found in surface waters in this region. However, regular monitoring of pesticide concentrations continues to find threshold exceeding levels of these substances. The water authority Delfland concludes[44] that (intended and unintended) discharges of pesticides into surface water are the most important source of pesticide contamination in the Delfland greenhouse area. Other contributing factors are:

- Leakage from hydroponic cultivation, for example through drainage systems or leaking floors;
- Groundwater contamination via soil-grown crops (and subsequent contamination of surface water)
- Sewerage system failure or insufficient buffer capacity.

Contamination of **surface and groundwater** within and around greenhouse areas resulting from neonicotinoid use in hydroponic systems appears to be highly likely. However, this would need to be quantified further for predicted levels of neonicotinoid usage in European Union greenhouses, and for both crops grown in soil and those in open or closed hydroponic systems. Bees and other pollinators are known to access surface water and be impacted by neonicotinoids that contaminate these resources. Contamination of soils and aquatic systems will also present a risk to a range of other organisms that inhabit these ecosystems.[45] Morrissey et al. (2015) indicate that the levels of neonicotinoids in aquatic systems often exceeds regulatory limits, and that their persistence means that current toxicity testing to guide the derivation of thresholds may underestimate their toxic potential to aquatic life.[46]

3.2 DUST

Godfray et al. (2014) report that the dust emitted from seed drilling machines can contain high concentrations of neonicotinoids that are known to contaminate adjacent crops, flowers and natural vegetation.[47] The use of neonicotinoids in greenhouses is thought to reduce the potential for dust to escape to adjacent areas although there are few, if any, scientific assessments to identify whether this is true. There is also a risk of contamination of adjacent areas from foliar sprays. The level of risk depends on whether the original product is in liquid or powder form. It is also not known whether the vents in the greenhouses are likely to be open during application, but this could greatly influence fugitive emissions from these systems if they are not closed or are opened soon after application.

3.3 OTHER MODES OF RELEASE

There are likely to be a number of other modes of release of neonicotinoids to the environment adjacent to treated greenhouses that have not as yet been fully characterised or quantified. These insecticides act systemically and are found throughout the tissues of the treated plant, including the flowers. This means that any waste plant material that is removed from the greenhouse during cultivation and after fruiting as described by both Anton et al. (2005) and Anton et al. (2005), could be contaminated with neonicotinoids. This waste may be stored onsite and then transported either to incinerators or landfill sites. Storage sites could be areas for leaching, depending on the conditions in which this material is kept. These storage sites may present additional exposure to other organisms such as birds, rodents, flying and crawling insects or spiders.

43 *http://www.priva-international.com/media/1176734/bestpracticeguidelines_whitepaper.pdf*

44 Hoogheemraadschap Delfland, 2017. Waterkwaliteitsrapportage 2016 *https://www.hhdelfland.nl/waterkwaliteitsrapportage-2016*

45 Pisa, L.W., Amaral-Rogers, V., Belzunces, L.P., Bonmatin, J.M., Downs, C.A., Goulson, D., Kreutzweiser, D.P., Krupke, C., Liess, M., McField, M., Morrissey, C.A. (2015). Effects of neonicotinoids and fipronil on non-target invertebrates. Environmental Science and Pollution Research 22: 68-102. doi.10.1007/s11356-014-3471-x

46 Morrissey, C.A., Mineau, P., Devries, J.H., Sanchez-Bayo, F., Liess, M., Cavallaro, M.C., Liber, K. (2015). Neonicotinoid contamination of global surface waters and associated risk to aquatic invertebrates: a review. Environment International 74: 291-303. doi: 10.1016/j.envint.2014.10.024

47 Godfray, H.C.J., Blacquière, T., Field, L.M., Hails, R.S., Petrokofsky, G., Potts, S.G., Raine, N.E., Vanbergen, A.J., McLean, A.R. (2014). A restatement of the natural science evidence base concerning neonicotinoid insecticides and insect pollinators. Proceeding of the Royal Society B 281: 20140558. doi. 10.1098/rspb.2014.0558

Waste plant material may also be composted and it is possible that the resulting compost material could be contaminated with recalcitrant neonicotinoid residues. Recent life-cycle assessments of open field and greenhouse grown lettuce and barley indicates that most vegetative waste from greenhouses is taken to the nearest landfill.[48] No information could be found on whether leachate from landfill sites containing greenhouse waste contains neonicotinoids.

Determining the level of neonicotinoids release to the environment within farms as a result of product preparation, mixing, storage and transfer on the clothing of workers would need further work and could be a useful area of research.

3.4 EXPOSURE TO ORGANISMS THAT GAIN ACCESS THROUGH GREENHOUSE VENTS

Greenhouse ventilation windows and vents are often intentionally opened, allowing access to organisms such as flying and crawling insects, spiders, slugs and snails. The degree to which these organisms visit greenhouses is unknown.

The potential for neonicotinoids to accumulate in ecosystems and travel through food webs may be underestimated. Most neonicotinoids are thought to have low bioaccumulation potential. A recent study investigated the potential for neonicotinoids to move through a food chain using laboratory and field conditions where soya bean seeds were coated with thiamethoxam.[49] Residue analyses showed that though thiamethoxam concentrations declined through successive levels in the food chain, concentrations found in field-collected slugs were still high enough to negatively impact their insect predators. Imidacloprid is known to be persistent in sediments for some time and this will present a risk to aquatic life.[50]

48 Bartzas, G., Zaharaki, D., Komnitsas, K. (2015). Life cycle assessment of open field and greenhouse cultivation of lettuce and barley. Information Processing in Agriculture 2: 191-207. doi. 10.1016/j.inpa.2015.10.001

49 Douglas, M.R., Rohr, J.R., Tooker, J.F. (2015). EDITOR'S CHOICE: Neonicotinoid insecticide travels through a soil food chain, disrupting biological control of non-target pests and decreasing soya bean yield. Journal of Applied Ecology 52: 250-260. doi. 10.1111/1365-2664.12372

50 Pisa, L.W., Amaral-Rogers, V., Belzunces, L.P., Bonmatin, J.M., Downs, C.A., Goulson, D., Kreutzweiser, D.P., Krupke, C., Liess, M., McField, M. and Morrissey, C.A. (2015). Effects of neonicotinoids and fipronil on non-target invertebrates. Environmental Science and Pollution Research 22: 68-102. doi.10.1007/s11356-014-3471-x

3.5 SIGNIFICANT KNOWLEDGE GAPS

There are many key knowledge gaps that make allowing the use of neonicotinoids in greenhouses contrary to the precautionary principle.

Some of knowledge gaps are presented below, though this list may not be exhaustive and there are likely to be others.

1. There are few or no publicly available data on the quantities of neonicotinoids used in greenhouses.

2. More information is needed on the methods, timing and circumstances of neonicotinoid application in greenhouse cultivation, specifically the mode of application and, in the case foliar sprays, the role of vents in allowing fugitive emissions.

3. There is little understanding of the environmental fate of neonicotinoids in general, and even poorer knowledge of how these substances might be released into the environment around greenhouses.

4. Neonicotinoids are known to be highly toxic to many invertebrates.[7] However, EFSA conclusions (2015; 2016) on thiamethoxam, clothianidin and imidacloprid state that there were data gaps on risk to honeybees, bumble bees and solitary bees for exposure scenarios such as contact and/or oral exposure to crops, field margins, adjacent and succeeding crops.[1, 2, 3, 4, 5, 6] The lack of information concerning the impacts of these substances is relevant for all uses, outdoor and in greenhouses. These reviews clearly state that there was a lack of information to address the risk to honeybees from exposure to contaminated water (surface water, puddles and guttation fluids) in outdoor uses, open-protected cropping and in permanent greenhouses.

5. The ecological risk assessments do not include the interaction between the use of pesticides and other stressors such as such as land use changes or disease.[51] Continuing the use of neonicotinoids in greenhouses, and not in other uses may reduce levels of contamination in some agricultural areas but will continue to present an unknown risk to organisms in localised areas. Potential negative impacts in tandem with other stressors could affect biodiversity in, and

51 van der Sluijs, J.P., Amaral-Rogers, V., Belzunces, L.P. et al. (2015). Conclusions of the Worldwide Integrated Assessment on the risks of neonicotinoids and fipronil to biodiversity and ecosystem functioning. Environmental Science and Pollution Research 22: 148. doi. 10.1007/s11356-014-3229-5

adjacent to, at least some of the 114,320 hectares currently farmed as permanent greenhouse agriculture in Europe and which is likely to increase in future.

6. Physical pathways for exposure to flying insects and crawling invertebrates that result for these organisms entering vented greenhouses are currently poorly understood.

7. Pathways and levels of exposure as a result of the removal of waste plant material from greenhouses are not known.

8. Information on the release of contaminated wastewater from greenhouses is not readily available and may be a significant cause for concern.

9. Prolonged low-dose contamination by neonicotinoids (one study focused on thiacloprid) can induce cumulative ecological effects that are currently not predicted or addressed by risk assessment frameworks.[52]

10. In general, the effects of global use of all pesticides, including neonicotinoids, on wildlife at higher levels of biological organisation – i.e. populations, communities and ecosystems – are not well understood.[53]

52 Liess, M., Foit, K., Becker, A., Hassold, E., Dolciotti, I., Kattwinkel, M., Duquesne, S. (2013). Culmination of low-dose pesticide effects. Environmental Science and Technology 47: 8862–8868. doi. 10.1021/es401346d

53 Köhler, H.-R., Triebskorn, R. (2013). Wildlife ecotoxicology of pesticides: can we track effects to the population level and beyond? Science 341:759–765. doi. 10.1126/science.1237591

4.0 THE NEED FOR APPROPRIATE RISK ASSESSMENTS

The key messages from the EFSA reviews1, [2, 3, 4, 5, 6] are:

1. With the exception of the risk to honeybees through the consumption of surface water, the risk to bees from foliar application of neonicotinoids in permanent greenhouses is "low". The risk to honeybees, the of the exposure to residues in surface waters could not be finalised. It should be "further considered" at the national level.

2. Exposure to bees from foliar spray applications and soil treatments in greenhouses could not be excluded (for example, bees entering the greenhouse through vents), but it was agreed that exposure to populations through this route was low. However, it was also noted that in areas with large-scale greenhouse production, this may not be the case.

3. No quantitative risk assessments were conducted for field margin or adjacent crop scenarios for neonicotinoid use on leafy vegetables in greenhouses as contamination of these off-field areas was considered to be negligible for this use. However, some exposure through this route could not be excluded.

4. In greenhouses with integrated pest management (IPM), it was noted that the use of neonicotinoids could present a high risk to beneficial insects and other organisms that are introduced as part of this management. IPM uses broad scale ecosystem-based methods to manage pest species, sometimes by introducing natural predators.

The high toxicity of neonicotinoids invertebrates has been confirmed, including lethal and sub-lethal effects on bees and other pollinators, predatory insects and sub-lethal effects on fish, reptiles, frongs, birds and mammals.[7] In the EFSA reviews, it was noted that various risk assessments were not carried out by EFSA due to lack of data. These include the assessment of the accumulative and sublethal effects of neonicotinoid use in all situations as well as the risk to honeybees from contaminated water (surface water, puddles and guttation). The risk assessment for contamination from imidacloprid and thiamethoxam metabolites was also not finalised.[54]

54 Domenica, A., Maria, A., Stefania, B., Alessio, I., Alberto, L., Tunde, M., Rachel, S., Csaba, S., Benedicte, V., Alessia, V. (2017). Neonicotinoids and bees: The case of the European regulatory risk assessment. Science of the Total Environment 579: 966-971. doi.10.1016/j.scitotenv.2016.10.158

The European Commission proposal to allow the use of neonicotinoids in greenhouses is not based on any scientific assessment that these uses are likely to be safe. It is clear that the continued use of neonicotinoids may risk exposure, and impacts, in ways that have not as yet been quantified, including the synergistic and additive reactions with other pesticides on non-target invertebrates[45], the direct and indirect effects on vertebrate wildlife[55,] and the risks to ecosystem functioning.[56]

As highly intensive agricultural areas, greenhouses represent a potentially large (at least 114,320 hectare) area of use. On the basis of the material accessed for the purposes of this document, there is likely to be some risk of contamination to surface waters that has not, as yet, been adequately assessed. There is, therefore, an unknown risk to bees, and other organisms, inhabiting these areas as well as a very high likelihood that neonicotinoid residues will escape the confines of the greenhouse systems

Several studies have identified that the use of neonicotinoids in greenhouse agriculture will affect pollinators and beneficial organisms as part of integrated pest management strategies within greenhouses.[18, 26, 28, 43, 57] Messelink et al. (2014) also highlights that populations of natural enemies that are useful in greenhouses are related to populations outside of these greenhouses.[58] If neonicotinoids are released from greenhouse areas this could also result in lower populations of such natural enemies.

55 Gibbons, D., Morrissey, C., Mineau, P. (2015). A review of the direct and indirect effects of neonicotinoids and fipronil on vertebrate wildlife. Environmental Science and Pollution Research 22: 103-118. doi. 10.1007/s11356-014-3180-5

56 Chagnon, M., Kreutzweiser, D.P., Mitchell, E.A.D., Morrissey, C.A., Noome, D.A., van der Sluijs, J.P. (2015). Risks of large scale use of systemic insecticides to ecosystem functioning and services. Environmental Science and Pollution Research 22: 119. doi. 10.1007/s11356-014-3277-x

57 Cloyd, R.A., Bethke, J.A. (2011). Impact of neonicotinoid insecticides on natural enemies in greenhouse and interiorscape environments. Pest Management Science 67: 3-9. doi. 10.1002/ps.2015

58 Messelink, G.J., Bennison, J., Alomar, O., Ingegno, B.L., Tavella, L., Shipp, L., Palevsky, E., Wäckers, F.L. (2014). Approaches to conserving natural enemy populations in greenhouse crops: current methods and future prospects. BioControl 59: 377-393. doi. 10.1007/s10526-014-9579-6

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