Seed-dressing systemic insecticides and honeybees

This document contains additional debate between Bayer CropScience and authors of the chapter 'Seed-dressing systemic insecticides and honeybees' Laura Maxim and Jeroen van der Sluijs.

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Please find below:

The Bayer CropScience view on Maxim and van der Sluijs 'Seed-dressing systemic insecticides and honeybees: a challenge for democratic governance of controversies on chemical risks' ([1])

Dr Richard Schmuck, Head of Department of Environmental Safety of Bayer CropScience

Other noteworthy aspects in the context of the situation in France which hopefully help achieve a more balanced debate include:

1. The authors only use selective data that support the conclusion of a causal link between seed-treatment and bee colony losses

In reporting scientific evidence that supposedly demonstrates unambiguously their premise the authors dismiss relevant and important data which contradict the conclusion of a causal link between neonicotinoid products and the bee colony losses. These publications that conclude that the use of neonicotinoids does NOT pose an undue risk to bees, or found no correlation between bee colony losses and exposure to neonicotinoid-treated crops, include: e.g. Belien et al. (2009), Chauzat et al. (2009), Faucon et al. (2004), Kirchner (1999), Nguyen et al. (2009). The authors admit that the scientific data considered in their evaluation was not exhaustive. The scientific literature on this topic is extensive. Still, the selection remains questionable.

Another reference which is surprisingly left out by the authors is the publication of Rivière-Wekstein (2006), who analyses the socio-political processes around the issue of bee colony losses in France. His book focuses on the Gaucho® and Régent® story. In essence, he explains that both of these a priori 'damned' insecticides were banned to serve a series of political, economic and other ambitions. They were also used as a scapegoat to hide difficulties encountered in bee management in France and were conveniently used to question an agricultural model based on technological progress. His revelations would have been very valuable source for an article that aspires to look at democratic governance of controversies over chemical risks.

2. The authors discredit data which do not support the causative link between seed-treatment and bee colony losses

The most striking example is the AFSSA (Agence Française de la Sécurité Sanitaire des Aliments) Report on weakening, collapse and losses of bee colonies (AFSSA, 2009). This comprehensive evaluation of bee losses in France was corroborated by independent scientists. It does, in contrast to the Comité Scientifique Toxique (CST, see point 3 below) (Doucet-Personeni et al., 2003), cited by the authors, analyse all potential causative factors behind bee mortality, not only pesticides, and comes to the conclusion that parasites and pathogens are key factors causing colony losses. Furthermore, it states: 'it is not currently possible to confirm or refute the hypothesis that chronic exposure of bee colonies to some of these products may play a direct or adjuvant role with respect to certain known biological pathogens.' The authors heavily criticize the technical validity of the report for this conclusion. Documents of doubtful balance and disputable scientific quality are however uncritically cited, like for example, the report of Kindemba (2009) which has just recently

[1] This text complements the Bayer CropScience view of 'Seed-dressing systemic insecticides and honeybees' by Laura Maxim and Jeroen van der Sluijs in the report '*Late lessons from early warnings: science, precaution, innovation'* available at: http://www.eea.europa.eu/publications/late-lessons-2

been reviewed and considered to be flawed by an independent bee scientist (Thompson, 2009).

3. The authors refer to the risk assessment approach of the Comité Scientifique Toxique (CST) which is no longer applied and has been replaced by an improved system suggested by the same French authorities, which before elaborated the CST

The risk assessment scheme originally proposed in the French CST report and referred to in the publication is today no longer applied either in Europe, or in countries outside of Europe. An improved risk assessment scheme specifically designed for systemic products is ready for implementation. It has been developed since 2005, by a working group of the International Commission for Plant-Bee Relationships (ICPBR), under the lead of the French authorities. In 2009 this scheme was approved by ICPBR and is ready for implementation (Alix et al., 2009a, b).

Another factor demonstrating that the French regulatory authorities do not consider seed-treatment uses of this class of insecticidal chemistry unsafe to bees and do not follow the CST system anymore is substantiated by the fact that since 2008, a seed treatment product (Cruiser®) has been authorized in France for use in maize, which belongs to the same class of chemicals as Gaucho® and has an almost identical hazard and exposure profile relative to honeybees.

4. The authors criticize the EU Risk Assessment System

The European risk assessment system for bees is criticized in general and particularly its use of field studies as highest-tier evidence (Section 16.2.2). The authors even claim that the step-wise approach of ecotoxicological risk assessment approach is a position of "Bayer-funded scientists" (Section 16.2.1). However, it is one of the principles of the European risk assessment system according to EU Directive 91/414 EEC, which has been endorsed by the regulatory authorities of all 27 member states of the EU. This system has been in force since the mid 1990s, and has proven its effectiveness for the protection of honeybees (see e.g. Brasse, 2005; Seefeld, 2005, 2006; Barnett et al., 2007; Thompson and Thorbahn, 2009).

Finally, the data and risk assessments submitted by Bayer CropScience, as well as the in-depth authority evaluation (66 pages in the Draft Assessment Report for bees exclusively), apply precisely the key criteria as specified by authors in their fifth lesson in Section 16.5, namely: reliable (all researchers mentioned), robust (criticism scientifically challenged study by study) and complete (all key external findings included).

5. The authors state that the current risk assessment does not sufficiently cover sublethal effects

The authors have criticized that sublethal effects would not be appropriately covered in the existing risk assessment schemes, nor that there would be appropriate standard methods to assess them (e.g. Sections 16.2.1 and 16.5). This is in clear contradiction to the standpoint of a significant part of the scientific community: e.g. in the 2005 ICPBR Symposium, the topic of sublethal effects was comprehensively discussed. The outcome of the discussion was that "Field studies present the most appropriate way of addressing sublethal effects given that they provide more realistic information than can be obtained from relatively simple laboratory-based studies. The meeting considered that the most appropriate use of the Bee Protection Group's resources would be to improve the design of higher tier studies rather than spending considerable time and effort developing and validating specific laboratory tests." (Lewis et al., 2007).

Semi-field and field studies, i.e., higher-tier studies, allow for testing relevant endpoints in an integrative way and in the natural complex social environment of bee colonies. Relevant sublethal effects which threaten the health of bee colonies would thus be expected to become evident in those field trials.

6. Stakeholder communication is very selectively scrutinized

Allegations of inconsistent communication or inconsistent subsequent statements only focus at Bayer (e.g. Section 16.4). However, changing statements or arguments from stakeholders blaming Gaucho® as the cause of the bee colony losses in France have not been similarly scrutinized. For instance, losses were firstly attributed to the direct exposure of honeybees to treated sunflower fields, and the observed symptoms were ascribed to intoxication by exposure to treated sunflower (Section 16.1). Later, although sunflower use of Gaucho® had been suspended in 1999, and the symptoms remained hypotheses were introduced which no longer had anything to do with sunflower (e.g. seed-treated maize, succeeding crops), though the original symptoms had been clearly linked to sunflower only (see also Aletru et al., 1998). The facts behind these inconsistencies are described by the authors, but the inconsistencies themselves as well as potential drivers were not addressed.

7. The authors confuse end-points of individual studies and risk assessment conclusions

In Section 16.2.1, a number of endpoints are listed, and those of public research are contrasted with "Bayer-funded research" ones. No differentiation is made between NOECs or LOECs of lower tier studies, and the overall NOEC resulting from higher tier studies used in the risk assessment according to EU legislation. By simply listing NOECs across tiers and reporting NOECs and LOECs, the authors confuse the reader and give the impression that data generated by Bayer-funded researchers and other researchers are conflictive and that Bayer CropScience claims NOEC figures which were already disproved by independent scientists (e.g. Section 16.2).

8. The authors unfairly discredit industry research even though it is rigorously monitored by the strict protocols of Good Laboratory Practice

The inappropriate and unsubstantiated disqualification of only the industry-funded research and researchers is either ill-informed or based on pre-condemnations. In contrast to what the authors consider to be "independent" academic research, the quality of data arising from the regulatory testing required of industry is rigorously scrutinized by the GLP system (Good Laboratory Practice). GLP is an OECD independently monitored quality assurance system that is required for the generation of all safety data. Under GLP, every step of a study and all data generated are accurately documented and thoroughly monitored in order to warrant full transparency and to prevent forgery or subsequent misuse or misinterpretation of data. This is a very rigid control mechanism and only one element in a multi-step process in which regulatory studies are being scrutinized at the level of national and/or EU authorization bodies.

9. The authors ignore the conclusions of the international bee scientist community about key factors involved in bee colony losses

Recently, comprehensive documents have been published by groups of independent bee scientists, which reflect the current status of research with regard to bee health and bee colony losses (Hendrikx et al., 2009, Special Issue "Colony Losses" of the Journal of Apicultural Research 2010). In none of these studies have neonicotinoid pesticides been identified as a relevant factor of bee colony losses. Conversely, the key factors involved in significant bee colony losses have been clearly identified as parasitic mites, associated diseases and Nosema infections.

References

AFSSA, 2009, *Weakening, collapse and mortality of bee colonies* (http://www.afssa.fr/Documents/SANT-Ra-MortaliteAbeillesEN.pdf).

Aletru, F., Chauvancy, F., Clément, F.H., Mary, M., Vedrenne, Y. and Vermandere, P., 1998, '1998 sunflower foraging observation report - Hive depopulation, abnormal colony and bee behaviour in areas of intensive arable farming in early summer', *La Coordination des Apiculteurs de France*; 1-6.

Alix, A., Chauzat, M.- P., Duchard, S., Lewis, G., Maus, Ch., Miles, M.J., Pilling, E., Thompson, H.M. and Wallner, K., 2009a, 'Guidance for the assessment of risks to bees from the use of plant protection products applied as seed coating and soil applications – conclusions of the ICPBR dedicated working group', *Julius-Kühn-Archiv*, 423: 15-27.

Alix, A., Chauzat, M.-P., Duchard, S., Lewis, G., Maus, Ch., Miles, M.J., Pilling, E., Thompson, H.M. and Wallner, K., 2009b, 'Environmental risk assessment scheme for plant protection products - Chapter 10: Honeybees – Proposed scheme', *Julius-Kühn-Archiv*, 423: 27-33.

Chauzat, M.-P., Carpentier, P., Martel, A.-C., Bourgeard, S., Cougoule, N., Porta, Ph., Lachaize, J., Madec, F., Aubert, M. and Faucon, J.-P., 2009, 'Influence of Pesticide Residues on Honey Bee (Hymenoptera: Apidae) Colony Health in France', *Environmental Entomology*, 38: 514-523.

Chauzat, M.-P., Carpentier, P., Madec, F., Bourgeard, S., Cougoule, N., Drajnudel, P., Clément, M.C., Aubert, M. and Faucon, J.-P., 2010a, 'The role of infectious agents and parasites in the health of honey bee colonies in France', *Journal of Apicultural Research*, 49: 31-39.

Chauzat, M.-P., Martel, A.-C., Zeggane, S., Drajnudel, P., Schurr, F., Clément, M.C., Ribière-Chabert, M., Aubert, M. and Faucon, J.-P., 2010b, 'A case control study and a survey on mortalities of honey bee colonies (Apis mellifera) in France during the winter of 2005-6', *Journal of Apicultural Research*, 49: 40-51.

Curé, G., Schmidt, H.W. and Schmuck, R., 2001, 'Results of a comprehensive field research programme with the systemic insecticide imidacloprid (Gaucho®)'. Proceedings of the Symposium "Hazard of Pesticides to Bees", Avignon (France), September 7-9, 1999, ed. INRA (Paris) (Les Colloques n°98): 49-59.

Doucet-Personeni, C, Halm, M. P., Touffet, F., Rortais, A. and Arnold, G., 2003, 'Imidaclopride utilisé en enrobage de semences (Gaucho®) et troubles des abeilles'. Rapport

final'. Comité Scientifique et Technique de l'Etude Multifactorielle des Troubles des Abeilles, 221 pp.

Faucon, J.P., Aurieres, C., Drajnudel, P., Ribiere, M., Martel, A.-C., Zeggance, S., Chauzat, M.P. and Aubert, M., 2004, 'Experimental study of the toxicity of imidacloprid distributed in feeder syrup to bee colonies (Apis mellifera)', AFSSA, Laboratory for studies and research into the pathology of small ruminants and bees, Sophia Antipolis: 32 pp.

Faucon, J.P. and Chauzat, M.P., 2008, 'Varroosis and other honey bee diseases: Major causes for colony mortality in France', *Bulletin de l'Academie Veterinaire de France*, 161: 257-263.

Genersch, E., Ohe, W. von der, Kaatz, H., Schroeder, A., Otten, Ch., Büchler, R., Berg, S., Ritter, W., Mühlen, W., Gisder, S., Meixner, M., Liebig, G. and Rosenkranz, P., 2010, 'The German bee monitoring project: a long term study to understand periodically high winter losses of honey bee colonies', *Apidologie*, DOI: 10.1051/apido/2010014 (www.apidologie.org): 1-21.

Hendrikx, P., Chauzat, M.-P., Debin, M., Neumann, P., Fries, I., Ritter, W., Brown, M., Mutinelli, F., Le Conte, Y. and Gregorc, A., 2009, *Scientific Report submitted to EFSA: Bee Mortality and Bee Surveillance in Europe* (https://secure.fera.defra.gov.uk/beebase/downloadNews.cfm?id=54).

Ivanova, E.N. and Petrov, P.P., 2010, 'Regional differences in honey bee winter losses in Bulgaria during the period 2006-9', *Journal of Apicultural Research*, 49: 102-103.

Kindemba, 2009, *The impact of neonicotinoid insecticides on bumblebees, honey bees and other non-target invertebrates*, BugLife, The Invertebrate Conservation Trust (http://www.buglife.org.uk/Resources/Buglife/Neonicotinoid%20insecticides%20report.pdf).

Kirchner, W.H., 1999, 'Mad-bee-disease? Sublethal effects of imidacloprid (Gaucho®) on the behaviour of honeybees', *Apidologie*, 30: 422.

Lewis, G., Thompson, H.M. and Smagghe, G., 2007, 'In Focus: Pesticides and honeybees – the work of the ICP-BR Bee Protection Group Editorial', *Pest Management Science*, 63: 1047-1050.

Maus Ch., Curée, G. and Schmuck, R., 2003, 'Safety of imidacloprid seed dressings to honey bees: a comprehensive overview and compilation of the current state of knowledge', *Bulletin of Insectology*, 56, 51-57.

Neumann, P. and Carreck, N.L., 2010, 'Honey bee colony losses', *Journal of Apicultural Research*, 49: 1-6.

Nguyen, B.K., Saegerman, C., Pirard, C., Mignon, J., Widart, J., Thironet, B., Verheggen, F. J., Berkvens, D., De Pauw, E. and Haubruge, E., 2009, 'Does Imidacloprid seed-treated maize have an impact on honey bee mortality?', *Journal of Economic Entomology*, 102: 616-623.

Rivière-Wekstein, G., 2006, 'Abeilles, l' imposture écologique : L'affaire des insecticides « maudits »', *Le Publieur*, 300 pp.

Schmuck, R., 1999, 'No causal relationship between Gaucho® seed dressing in sunflowers and the French bee syndrome', *Pflanzenschutz-Nachrichten Bayer*, 52: 257-299.

Saddier, M., 2008, 'Pour une filière apicole durable. Les abeilles et les pollinisateurs sauvages', Rapport au Premier Ministre Francois Fillon.

Thompson, H., 2009, *Response to Buglife report on "The impact of neonicotinoid insecticides on bumblebees, honey bees and other non-target invertebrates"* (https://secure.fera.defra.gov.uk/beebase/downloadNews.cfm?id=47).

Thompson, H.M. and Maus, Ch., 2007, 'The relevance of sublethal effects in honey bee testing for pesticide risk assessment', *Pest Management Science*, 63:1058–1061.

Thompson, H.M. and Thorbahn, D., 2009, 'Review of honeybee pesticide poisoning incidents in Europe – evaluation of the hazard quotient approach for risk assessment', *Julius-Kühn-Archiv*, 423: 103-108.

Tlak Gajger, I., Tomljanovic, Z. and Petrinec, Z., 2010, 'Monitoring health status of Croatian honey bee colonies and possible reasons for winter losses', *Journal of Apicultural Research*, 49: 107-108.

Response to the Bayer Cropscience (Richard Schmuck) comments on the chapter ([2])

Laura Maxim and Jeroen van der Sluijs

References to French non-scientific publications on Gaucho® and honeybee losses

There is a vast amount of literature on the subject of honeybee losses and of their link with neonicotinoid insecticides. As specified in our chapter, due to limitations in the length of the chapter, we were forced to reduce the number of references, which we did by focusing on those reflecting the different positions manifesting during the controversy. The references indicated by Mr Schmuck do not bring additional arguments compared to those already included in our chapter.

Indeed, we have not cited Rivière-Wekstein (2006) in our chapter, as the length of our paper did not allow us to relevantly include reference to the books written in France on the subject of Gaucho® by journalists, policy-makers or NGOs. For this reason, we have not included several books either such as:

- de Villiers, Philippe, 2004. Quand les abeilles meurent, les jours de l'homme sont comptés: un scandale d'Etat (When honeybees die, the human life is in danger: a State scandal), Albin Michel, 165 pp. This book, whose author was candidate to the French Presidency, French deputy and later European deputy, insists on the incapacity of the pesticides' regulatory assessment methods to grasp the risks of seed-dressing insecticides. It also highlights the dysfunctions in the French administrative system responsible at that time of regulating pesticides, its lack of transparency, its practices of selecting experts based on political objectives, and of engaging always more studies and creating new expertise structures without decisional follow-up ("it is urgent to wait"), its lack of adequate human resources for a good functioning, briefly, what this author calls the "*irresponsible productivism manipulated by the industry, but also the passive complicity of the administration*".
- Cicolella, André and Benoît-Browaeys, Dorothée, 2005. Alertes santé: experts et citoyens face aux intérêts privés (Alerts on health: experts and citizens face to private interests), Fayard, pp. 75 – 91, also insisting on the inadequacy of the regulatory framework of assessing the risks of pesticides, the close relationships between industry and the administration supposed to regulate the risks of its products, and the confusion between evaluation and management - to the point that administrations take illegal decisions and creates a "culture of lying".
- Cintas, Estelle, 2007. Une femme contre les pesticides: une vie, un combat (A woman against pesticides: a life, a battle), Sang de la terre, pp 103 – 125. The author of this book describes the despair of a family of beekeepers having suffered honeybee losses, and their indignation in front of the attitude of Bayer focused on discrediting beekeepers' work and knowledge, and on intimidation.
- Nicolino, Fabrice and Veillerette, François (2007). Pesticides: revelations sur un scandale français (Pesticides: revelations about a French scandal), Fayard, 379 pp., a book that, as the back cover describes it, "gives names and dates, and delve into the archives. Yes, supposedly scientific congresses have been fiddled. Yes, the industry

[2] This text complements Laura Maxim and Jeroen van der Sluijs' reply to the Bayer CropScience view of 'Seed-dressing systemic insecticides and honeybees: a challenge for democratic governance of controversies on chemical risks' in the report 'Late lessons from early warnings: science, precaution, innovation' available at: http://www.eea.europa.eu/publications/late-lessons-2

> has infiltrated, and continues to do so, the official commissions charged with pesticides' control. Yes, the "reasoned agriculture" that French policy-makers present as the solution for the future, is a practical joke, an incredible manipulation. Reading this fascinating story, you will discover the scandalous role of the high administration of our country in the loss of billions of honeybees."

Reference to the AFSSA (2009) report

We cannot "*discredit data which do not support the causative link between seed-treatment and bee colony losses*" by criticizing AFSSA (2009) simply because our object is not generally "seed-dressing", but sunflower and maize seed-dressing with Gaucho®. Mr Schmuck uses generalization for criticizing elements supposedly existing in our chapter but which do not really exist in our text.

Thus, at the time of AFSSA, 2009, Gaucho® had been banned in sunflower and maize areas for 5 years already. So we could not criticize AFSSA (2009) for discrediting data on Gaucho® in sunflower and maize seed-dressing, simply because AFSSA (2009) does not deal with this issue.

As we have written in our chapter "*AFSSA (2009) does not assess the influence of Gaucho® and Régent® on honeybees, in sunflower and maize areas (e.g., the word Gaucho® is present 4 times in the main text of the document, twice for naming the precautionary decision of the Ministry and twice for naming the corresponding CST report).*"

Our analysis of AFSSA (2009) relates to the conclusion of this report about "pesticides", for showing the evolution of the evidence produced by one of the main stakeholders of the case. But, as we have written in our chapter: "*It is not clear to which "pesticides" the text refers to. Do the authors refer to all pesticides?*"

This report has only very limited relevancy for the issue of seed-treatment.

The question that had been addressed by the CST was to start by assessing the risk of one potential cause (Gaucho) among the several causes possible, involved in honeybees losses. Other causes had to be studied after the results produced by the CST, which had been done by AFSSA. There is no contradiction in that fact that honeybees can die both from exposure to imidacloprid and from diseases (or even from synergism among the two of them!).

We have quoted Kindemba (representing an NGO) for presenting the position of several NGOs at European level about the European standards, as we have quoted Bayer for presenting the position of Bayer, the beekeepers for presenting the position of beekeepers, etc.

Risk assessment schemes for pesticides and honeybees, at EU level: drafting a new scheme

The SANCO draft Guidance document on terrestrial ecotoxicology from 17 October 2002 (SANCO/10329/2002) recognizes that the method for assessing the pesticides' risk assessment established under the Directive 91/414/EEC is only adequate for spray pesticides. The use of HQ and its critical value had been obtained and included in regulatory demands based on data obtained on sprayed pesticides: "*The critical HQ is only applicable to situations and conditions which have been included in the validation; for example, with both, arthropods and bees, the validation included spray applications only*" (pp. 9).

The European risk assessment scheme has been recognized to be framed for sprayed pesticides but "of limited relevance for non-sprayed products" (Alix and Vergnet, 2007, p.

1070), and this is the reason for which it was recently demanded to ICPBR to develop a new framework. Indeed, Directive 91/414/EEC addressed the question of non-sprayed products "*very succinctly*" (Alix and Vergnet, 2007, p. 1070). In other words, it is recognized that the risk assessment scheme used by Bayer for obtaining its marketing authorization for Gaucho® in the 1990's was in fact unable to grasp the exposure pathways of honeybees to this insecticide.

The inadequacy of the current tests is recognized by official country-level bodies in OECD countries. Thus, the OECD (2010) survey showed that a large majority of countries indicate that current OECD toxicity studies designs do not adequately evaluate potential sub-lethal effects of pesticides on adult and larval honeybees. All the countries that replied to the request to identify weaknesses in the current tests conducted on bees pointed to the lack of adequacy of current study periods for the examination of chronic effects.

All these references confirm that the CST had therefore correctly appreciated the lack of adequacy, for seed-dressing insecticides, of the risk assessment regulatory scheme in force when Gaucho® was authorized for marketing (in 1992-3).

Furthermore, the quality and legitimacy of so-called "new" scheme promoted by ICPBR, to which Mr Schmuck refers, has recently come under question at European level. Consequently, the European Commission designed the European Food Safety Agency for working on a new scheme and really adapting the risk assessment method to systemic pesticides. This work is ongoing at the EFSA.

In our opinion, the simple participation of members of the French Food Agency in the working group having drafted the ICPBR risk assessment proposal cannot be considered as representing "*the French authorities*".

Looking closer at the composition of that group having proposed the schemes of Alix et al, 2009a,b, one can find that, among the 9 authors:

- 3 are representing pesticide producing companies (Bayer, Dow Chemicals and Syngenta),
- 3 are members of the previous AFSSA (French Food Safety Agency); among the three, Sophie Duchard had worked for the pesticide producing company BASF before working for AFSSA, and Anne Alix had worked for the chemical company Novartis before being employed by AFSSA; currently, she left AFSSA for working for Dow Agrosciences.
- 1 is member of the Central Science Laboratory, which is a governmental structure in UK and has already published together with persons from Bayer,
- 1 is member of a private consultancy company,
- only 1 is a university researcher.

This composition is largely misbalanced between members representing governmental structures or private interests, and scientists working in the public research. Furthermore, it is astonishing that pesticide producers are largely represented, whereas beekeepers are not. However, the honeybee is the daily object of their work, and their good knowledge of it would have certainly helped. Furthermore, academic science is largely under-represented.

This is not an isolated example. We could also refer to the similar case of the recent proposal for a brood test made by the Bee Brood Working Group of the ICPBR. This ICPBR Bee Brood working group is made of:

- 2 representatives of the industry (BASF and Bayer)
- 2 representatives of official national agencies dealing with pesticides: AFSSA (France), and CSL / Fera (UK, National Bee Unit, The Food and Environment Research Agency)
- 1 representative of a federal research institute, which is also a higher federal authority (Julius Kühn Institute - Federal Research Institute for Cultivated Plants, Germany)
- 1 representative of a company providing pesticides risk assessment services to companies.
- No academic scientist, no beekeeper, in this working group.

Furthermore, during the process of revision of the EPPO standard, having produced the document to which Mr Schmuck makes reference, under the lead of ICPBR, beekeepers represented by the European Beekeeping Coordination have repeatedly made comments to the draft proposals. These proposals were never taken into account.

A closer look at the functioning of ICPBR shows that their 10th symposium in Bucharest, in 2008, has been sponsored by several chemical companies among which BASF, Bayer Cropscience, Dow Agrosciences, Dupont and Syngenta. Among the participants in this symposium, 43% were representing private companies, 24% governmental agencies (like AFSSA), 21% were representing research structures and only 9% were beekeepers.

In other words, the process of revising the standards have been completely took over by pesticide producing companies and governmental risk assessment structures.

In the light of these examples, we think that the comment of Mr Schmuck raise several highly important questions:

- **How are the ICPBR Bee Protection group and its working subgroups created?**
- **Who decides who are the members?**
- **Who decides, after comments from the different ICPBR delegates, which are the comments to include in the new standard, and which are the comments to leave out?**
- **Why have contributions from public scientists and beekeepers been given such a low consideration while their contributions where and are highly relevant and to the point?**

... in brief, **HOW ARE THE STANDARD TESTS FOR HONEYBEES CREATED?**

This is an important question, because the standardized tests influence which is the “acceptable” evidence of risk and which is not. Meaning that it influences the risk which will “pass” and the risk which will not be considered "acceptable", and in the end it influences the balance between who gets the benefits of marketing a pesticide and who suffers the risks. Indeed, pesticides risk assessment is as much a technical question as it is an economic and a social question.

Therefore:

- public scientists, proved to be competent on the issue, should be involved in developing risk assessment schemes, in order to strengthen their scientific robustness

- all the concerned parties owning relevant knowledge, such as beekeepers in the case of honeybees, should be involved in test development (please note that "involvement" does not mean "asking and deciding afterwards if their comments will be considered or not")

- the choice of the experts involved, and the whole procedure of developing the tests, should be completely transparent, and current practices reviewed. Even if science-based, authorization tests are strong political tools and there is no reason for not submitting them to the democratic control common to our political life. This is even more the case because chemicals affect all European citizens, because they are present in all the aspects of our daily life.

But, let's discuss more specifically the "new" risk assessment scheme recently proposed by EPPO (2010a) based on Alix et al. (2009a):

1. Regarding risk calculation, Alix and Vergnet (2007, p. 1077) were stating: ".. a new risk assessment calculation should be implemented, in the form of either a toxicity exposure ratio (TER) or a PEC/PNEC ratio (…) In France, the PEC/PNEC ratio is preferred, as it already integrates the assessment factor, if any."

This paper considers that acute oral toxicity tests "may be of less relevance in describing the potential lethal impact of repeated or chronic consumption of contaminated food" (…) A method for measuring the toxic level of orally administered substances to caged bees over a 10 day period has been published[34]. Such a method would bring a suitable endpoint for chronic and repeated exposure of foraging bees [LD50 for survival or preferably NOEL (No Observed Effect Level) for survival and sublethal effects] but requires further validation to be routinely used in a regulatory context." (p. 1076)

The paper proposes investigation of the sublethal effects in laboratory, prior to higher-tier studies.

2. Two years later, Anne Alix published another paper, with colleagues mentioned above (3 from industry, 3 from AFSSA, 1 from the Central Science Laboratory, 1 consultant and 1 university researcher) (Alix et al., 2009a):

a) The decisive first step is the calculation of a Toxicity Exposure Ratio (TER), based exclusively on acute toxicity (LD50 / exposure).

b) It is proposed that chronic toxicity "*could be derived from 48h LD50 by applying an adjustment factor of 10, for acute toxicity data ranging from 0.13 to 90 µg/bee*" (pp. 22). Chronic toxicity could be investigated in laboratory only if TER is below 10, in a second step of the assessment, but this step is not compulsory and can be skipped.

c) The word "sublethal" is not mentioned in this paper. The effects on behavior are considered to be identifiable in semi-field and field tests.

3. Finally, the new risk assessment scheme (EPPO, 2010a) states, from the beginning, that the most reliable risk assessments are based on field tests. They are assumed to be better and therefore given priority compared to laboratory studies and to semi-field trials.

Regarding the factor of 10 between acute and chronic effects considered, based on a DEFRA study, the ratio of 10 is not respected for all substances; for example, for imidacloprid, results show a ratio of 5916, between the lowest DL50 for a 10-days study (0,012 ng/honeybee) and the highest DL50 for a 48h study (71 ng/honeybee). Each of the 7 substances considered by DEFRA for obtaining this 10 ratio showed different ratios between acute and chronic toxicity. Comparing to the 10 ratio, the difference with the real ratios ranges from +6 (chlorpyrifos methyl) to -463 (fipronil) (Simon, 2010).

The pathway away from the adequate risk assessment approaches proposed in the CST, via the paper of Alix and Vergnet (2007) towards the final inadequate EPPO scheme illustrates the processes of test building and of politization of science. The initial approach has been transformed in a political tool through negotiations in which academic scientists and beekeepers have been irrelevantly involved or excluded.

For example, the comments made by the European Beekeeping Coordination have been ignored during the ICPBR sessions, hence there's no meaning to potentially say that beekeepers are "asked" or "involved" if their opinion is not considered.

Despite the fact that ICPBR succeeded in promoting a new EPPO standard, which is finally very similar to the old one, the question of risk assessment of systemic pesticides is not closed, as it is shown by criticism by the Corporate Europe Observatory and European Beekeeping Coordination (2010) and by the resumption of work of assessing the risk assessment scheme at the EFSA in 2011.

The comment of Mr Schmuck referring to the Draft Assessment Report (DAR) perplexes us: whereas in our chapter we specify that no single reference is made to the important work by Jean-Marc Bonmatin, a French researcher having extensively worked and published on imidacloprid and honeybees, Mr Schmuck maintains that all researchers have been mentioned in the DAR report…

Risk assessment schemes for pesticides and honeybees, at EU level: Field and laboratory trials

We are not aware of scientific publications showing the higher relevancy of field trials compared to laboratory trials.

During the ICPBR meeting mentioned by Mr Schmuck, the European Beekeeping Coordination have submitted numerous comments concerning the inclusion of sublethal and chronical aspects in new tests, during the process of drafting the ICPBR proposals of revised standards, but these comments have been largely ignored.

The capacity of (semi-)field tests for demonstrating supposed absence of potential effects on honeybees, especially in the light of sublethal and chronic effects, can be largely criticized:

- These tests are not reproducible. Whereas for laboratory experiments most of the parameters of the honeybees' environment can be controlled, and thus insure reproducibility, almost nothing can be controlled in field tests, which thus become completely dependent of the variability of the local conditions.

- The relevancy of the control can be doubted (systemic insecticides are everywhere, as already shown in several studies)

- As the Netherlands Health Council (2000) concluded: *"Designing field trials for the purpose of demonstrating the absence of previously (i.e. in the first tier) presumed effects, places great demands on the quality of the trial, especially with regard to its statistical power. This must be sufficient to allow for the detection of changes that might be regarded as ecologically relevant. Only then does the absence of a statistically significant effect mean that there has, in all probability, been no ecologically relevant effect."*.
  The study by Cresswell (2011) has shown that most field trials published so far lack the required statistical power.

- Replicates: "*although very desirable, replication is often not feasible because of the requirements for separation*" (EPPO, 2010b, p. 318)

- they are "*difficult to conduct*" (EPPO, 2010a, p. 323) and therefore there is a chance that they are not correctly set up;

- the variability seems impossible to control, therefore the representativeness of "one shot" results for the whole range of situations where honeybees are exposed cannot be assumed; the semi-field and field test are not sensitive to the effect of the chemical, as much more as it is impossible, in real conditions, to prevent honeybees going on other flowers than those treated. There is a high potential of recording false negatives. If no rigorous residue analysis is done each time, nothing can be said about the exposure of the honeybee to the substance "assessed".

- statistical analysis is difficult or even impossible for endpoints highly important for systemic insecticides, such as behavioral endpoints: "*When interpreting the results, it needs to be recognized that there are endpoints which are intrinsically suitable for statistical evaluation (e.g., mortality data) whereas others may be unsuitable (e.g., behavioral endpoints)*" (p. 330) "*Due to limitations on replication in field studies and the inherent variability in most of the relevant endpoints assessed, it has to be recognized that statistical analysis may not be feasible*" (EPPO, 2010a, p. 330).

- the level of subjectivity in the interpretation of the results is very high. "*Field studies may be also difficult to interpret*" (EPPO, 2010a, p. 323), "*effects as a result of the experimental treatment in semi-field or field trials may be difficult to assess and to distinguish from other sources of mortality*" (p. 330). "*Whether or not statistical analysis is available, expert judgment will be needed to assess the biological significance of any effects seen in the context of each colony and the test conditions*" (p. 330). In simple words… it depends on who is the expert, and on what (s)he is competent and/or willing to "see".

- any criteria of quality / validity of semi-field and field tests are developed, for being sure that these tests are rightly realized, and that their results can be checked by an external reviewer.

Furthermore, the demonstration of the exposure cannot be rigorously established. There is no clear demand in the EPPO scheme for such a demonstration. The standard says that "*It should be demonstrated that the bees were at risk under the environmental conditions of the trial (especially weather), preferably by pollen analysis, assessing the flight intensity at the time of application in the field and by observation of the activity at the hive entrance*" (p. 329). If colonies are starting the field tests already having food provisions (as demanded in the test), very careful check should be done for confirming that honeybees have really been exposed to

the substance, or if they have consumed the (potentially uncontaminated) honey and pollen reserves already available in the hive.

Regarding specifically chronic and sublethal effects in (semi-)field tests, Alix and Vergnet (2007, p. 1077) highlighted well that relevant sublethal effects cannot be grasped in field or semi-field studies: "*Some of the behavioral impairments in Table 2 are almost impossible to follow outside the hive, so that they cannot be investigated in studies with colonies. (…) Observation of trembling, abdomen tucking, excessive cleaning, knockdown, aggressiveness and lack of coordination in laboratory tests could suggest the need for further behavioral investigation in higher-tier studies*"

Recent published studies (Creswell, 2011) further showed that published field trials that have reported no effects on honeybees from neonicotinoids, were incapable of detecting sublethal effects with conventionally accepted levels of certainty.

Furthermore:

- exposure through plant guttation, water sources and dust is not considered
- in semi-field tests, the distance covered by foragers is much lower than in real conditions, therefore their energetic needs might be very different, and the consumption of potentially contaminated honey / nectar too
- in semi-field conditions, confinement appears to restrict brood development, and therefore prevents from correctly observing the effects of the substance on it
- potential synergic effects between low doses of insecticide and diseases are not considered (Simon Delso, 2010).

Given the variability of the natural situations in which honeybees can be exposed, and the difficulties of standardizing many aspects of field trials, nothing can be deduced regarding the representativeness of current tests for the whole range of situations in which honeybees will be exposed to the insecticide.

Risk assessment schemes for pesticides and honeybees, at EU level: what GLP can and cannot do

GLP is a system of management controls for laboratories, a framework in which laboratory studies are planned, performed, monitored, recorded, reported and archived.

The GLP certification does not allow insuring that the protocol chosen for a study is the right one, that it conforms to honeybee biology, that the LD and LQ are adequate to the concentrations to be measured (e.g., low enough), that the results are correctly interpreted, etc.

In other words, it is possible to make a flawed study (e.g., choosing the wrong method, or the inadequate detection or quantification limit) all by respecting GLP rules.

Beyond pesticide risk assessment, this criticism of GLP practices is valid for more generally for chemical risk assessment, as shown by the recent debate on the risk assessment of bisphenol-A. Thus, a group of American scientists (Myers et al., 2009a) were showing that: "Although the U.S FDA and EFSA have deemed two industry-funded GLP studies of BPA to be superior to hundreds of studies funded by the U.S NIH and NIH counterparts in other

countries, the GLP studies on which the agencies based their decisions have serious conceptual and methodological flaws. In addition, the U.S. FDA and EFSA have mistakenly assumed that GLP yields valid and reliable scientific findings (i.e., "good science"). Their rationale for favoring GLP studies over hundreds of publically funded studies ignores the central factor in determining the reliability and validity of scientific findings, namely, independent replication, and use of the most appropriate and sensitive state-of-the-art assays, neither of which is an expectation of industry-funded GLP research" (p. 309)

Indeed, "GLP studies do not guarantee the reliability or validity of scientific results. Unfortunately, although GLP creates the semblance of reliable and valid science, it actually offers no such guarantee. GLP specifies nothing about the quality of the research design, the skills of the technicians, the sensitivity of the assays, or whether the methods employed are current or out-of-date. (All the above are central issues in the review of a grant proposal by an NIH panel). GLP simply indicates that the laboratory technicians / scientists performing experiments follow highly detailed U.S EPA requirements (or, for the EU, Organization for Economic Co-operation and Development (OCDE) requirements) for record keeping, including details of the conduct of the experiment and archiving relevant biological and chemical materials (I.S EPA 2008).

These record-keeping were instituted because of widespread misconduct being commited by commercial testing laboratories (described above). These fraudulent results were possible because contract laboratory studies used in regulatory process are rarely subject to the checks and balances that peer-reviewed, replicated scientific findings undergo. Without that acid test of reliability (replication by other independent scientists), other procedures were needed. Hence GLP was implemented, despite its severe limitations" (p. 311)

For examples of scientific flaws of GLP studies considered in the case of Bisphenol A: "*The fact that Tyl et al. (2002) adhered to GLP did not protect them from using insensitive animals*" (p. 311)

The representatives of the American Industry Council, Crop Life America, American Petroleum Institute, Soap and Detergent Association and Grocery Manufacturers Association, responded to Myers et al., saying that "*we strenuously disagree with the authors mischaracterization of the purpose and function of GLP and with their conclusion that GLP has no utility for weighting the reliability of studies*", in a letter "*reviewed in accordance with the peer- and administrative review policies of the authors' organizations*" (Becker et al., 2009, p. 482)

From their exchanges with the industry, Myers et al. (2009b) deplored a deaf dialogue: "*Becker et al. appear to have missed the point of our commentary entirely*".

How does our chapter relate with other honeybee losses than those found in France (1994-2004)?

As we have already highlighted many times in our exchanges with Mr Schmuck and again in these comments, the object of our chapter is in no case "the state of bee colony losses". This object is anyway so large, that it can't be even dealt with in one chapter alone, and probably in one book alone either. As much more as Mr Schmuck refers to the international arena.

Colony losses have different signs and causes in different places in a country or in the world, consequently everything cannot be mixed together in a single fuzzy term of "colony losses". This is what multicausality means, and one of the references cited by Mr Schmuck frames it: "*There is a consensus amongst the scientific community that the causes of colony losses in*

Europe and in the United States are likely to be multifactorial (in the two aspects of this term: combination of factors at one place and different factors involved according to place and period considered." (Hendrikx et al., 2009, p. 4). What this study particularly highlights is the important methodological weaknesses of surveillance systems all over Europe and the lack of representative data in Europe for colony losses, which prevents from proclaiming sufficient knowledge about colony losses based on epidemiological data. In no case, this study allows deciding that such or such cause is "key". Regarding neonicotinoids, Hendrikx et al. (2009) content themselves to classify the literature based on different levels of proof and raise the question of synergic effects between sublethal concentrations and diseases.

The special issue of the Journal of Apicultural Research cited by Mr Schmuck had the objective to present colony losses in Europe but did not address neonicotidoinds in particular. In the 30 to which we had full access (from a total of 31 papers in this special number), the word "**neonicotinoid**" is present in only 3 papers:

- In the paper of Mutinelli et al., Honey bee colony losses in Italy, where the word "neonicotinoid" is present only once: "Analysis of samples collected from weak or dying colonies in spring 2008, during the maize sowing period, showed that 57.5% of the 132 suspected poisoned dead bee samples were positive for neonicotinoids (Mogliotti, 2008; Mutinelli et al., 2009), thereby confirming poisoning of the bees."

- in the two papers of Chauzat et al., A case report of a honey bee colony poisoning incident in France, and Chauzat et al., A case control study and a survey on mortalities of honey bee colonies (Apis mellifera) in France during the winter of 2005-6. The first paper analyses the case of a honeybee loss in five sites, among which one was concerned by the effects of the neonicotinoid clothianinidin and the four others by other effects, which could be in part explained by the presence of pathogens. The second paper analyses the honeybee losses during the winter 2005-6 and concludes at the influence of pathogens on the losses found.

The word "**imidacloprid**" is also present in only 3 (of 30) papers:

- once about losses in Greece:
  "*Colony losses during the spring and summer of 2008 (approximately 3-6%) were also reported, and thought to be due to plant protection products. Of these, 70% occurred on cotton fields, where imidacloprid is sprayed or used as a seed dressing*."

- once in the first paper of Chauzat et al. above addressed above but which do not deal directly with this molecule

- several times in the second paper of Chauzat et al. indicated above. In this paper, analyses of pesticides including imidacloprid had been done in several matrixes; the study concludes at the absence of influence of the pesticides analyzed for the given apiaries.

The 31th paper deals with the genetic diversity in relation to the vitality and health of honeybee populations.

The word "neonicotinoid" or "imidacloprid" not being even present in their text, the others papers excepting the second one of Chauzat et al. cannot be considered as relevant sources for judging the role of neonicotinoids in bee disorders and colony losses because they address completely different research questions.

References

Alaux, C., Brunet, J. L., Dussaubat, C., Mondet, F., Tchamitchan, S., Cousin, M., Brillard, J., Baldy, A., Belzunces, L. and Le Conte, Y., 2009, 'Interactions between Nosema microspores and a neonicotinoid weaken honeybees (Apis mellifera)', Environmental Microbiology, 12(3): 774–782.

Alix, A. and Vergnet, C., 2007. Risk assessment to honey bees: a scheme developed in France for non-sprayed systemic compounds. Pest Management Science, 63(11):1069-80.

Alix, A., Chauzat, M.P., Duchard, S., Lewis, G., Maus, C., Miles, M.J., Pilling, E., Thompson, H.M. and Wallner, K., 2009a. Guidance for the assessment of risks to bees from the use of plant protection products applied as seed coating and soil applications – conclusions of the ICPBR dedicated working group. Julius-Kühn-Archiv, 423: 15-27.

Alix, A., Chauzat, M.-P., Duchard, S., Lewis, G., Maus, C., Miles, M.J., Pilling, E., Thompson, H.M. and Wallner, K., 2009b. Environmental risk assessment scheme for plant protection products - Chapter 10: Honeybees – Proposed scheme. Julius-Kühn-Archiv, 423: 27-33

Bacandritsos, N., Granato, A., Budge, G., Papanastasiou, I., Roinioti, E., Caldon, M., Falcaro, C., Gallina, A and Mutinelli, F., 2010. Sudden deaths and colony population decline in Greek honey bee colonies. Journal of invertebrate pathology, 105: 335 – 340.

Becker, R.A., Janus, E.R., White, R.D., Kruszewki, F.H., Brackett, R.E., 2009. Good laboratory practice and safety assessments. Environmental Health Perspectives, 117(11): 482-483.

Bonmatin, J.M., Moineau, I., Charvet, R., Colin, M.E., Fleche, C. and Bengsch, E.R., 2005. Behaviour of Imidacloprid in Fields. Toxicity for Honey Bees. In: Lichtfouse, E., Schwarzbauer, J., Robert, D. (eds.), Environmental chemistry. Green chemistry and pollutants in Ecosystems. Springer, 483-494.

Chauzat, M-P., Martel, A-C., Cougoule, N., Porta, P., Lachaize, J., Zeggane, S., Aubert, M., Carpentier, P., and Faucon, J-P., 2010. An assessment of honeybee colony matrices, Apis mellifera (Hymenoptera: Apidae) to monitor pesticide presence in continental France. Environmental Toxicology and Chemistry, doi: 10.1002/etc.361

Corporate Europe Observatory and European Beekeeping Coordination, 2010. Is the future of bees in the hands of the pesticide lobby? 7 pp., (http://www.biobees.com/library/background_theory_research/CEO_Neonics_Industry_EU-1.pdf)

Cresswell, J.E., 2011. A meta-analysis of experiments testing the effects of a neonicotinoid insecticide (imidacloprid) on honey bees. Ecotoxicology, 20(1):149-57.

Cummins, J., 2007. Parasitic Fungi and Pesticides Act Synergistically to Kill Honeybees? ISIS Report 07/06/07

Drofenik, J. 2011. Letter by the Phytosanitary Administration, Republic of Slovenia, Ministry of Agriculture, Forestry and Food, Ljubljana, to European Commission DG SANCO, dd 2 May 2011, regarding the clothianidin bee poisoning situation in Slovenia.

EPPO/OEPP, 2010a. Environmental risk assessment scheme for plant protection products. Chapter 10: honeybees. EPPO Bulletin, 40:323-331.

EPPO/OEPP, 2010b. Efficacy evaluation of plant protection products. Side effects on honeybees. EPPO Bulletin, 40:313-319.

Girolami, V., Marzaro, M., Vivan, L., Mazzon, L., Greatti, M., Giorio, C., Marton, D. & Tapparo, A. 2012. Fatal powdering of bees in flight with particulates of neonicotinoids seed coating and humidity implication, Journal of Applied Entomology, vol. 136, no. 1-2, pp. 17-26.

Girolami, V., Marzaro, M., Vivan,L., Mazzon, L., Giorio, C., Marton, D. and Tapparo, A., in press. Aerial powdering of bees inside mobile cages and the extent of neonicotinoid cloud surrounding corn drillers, Journal of Applied Entomology.

Guez, D., Belzunces, L.P., Maleska, R., 2003. Effects of imidacloprid metabolites on habituation in honeybees suggest the existence of two subtypes of nicotinic receptors differentially expressed during adult development. Pharmacology, Biochemistry and Behavior, 75:217 – 222.

Krupke, C.H., Hunt, G.J., Eitzer, B.D., Andino, G., and Given, K., 2012. Multiple Routes of Pesticide Exposure for Honey Bees Living Near Agricultural Fields. PLoS ONE 7(1): e29268. doi:10.1371/journal.pone.0029268

Lewis, G., Coulson, M., Vergnet, C., Maus, C., Thompson, H.M., Becker, R., Rogers, D. and Tornier, I., 2009. Proposed revision of the higher testing requirements for EPPO standard PP1/170: test methods for evaluating the side-effects of plant protection products on honeybees. Julius-Kühn-Archiv, 423: 34-42.

Marzaro, M., Vivan, L., Targa, A., Mazzon, L., Mori, N., Greatti, M., Toffolo, E.P., di Bernardo, A., Giorio, C., Marton, D., Tapparo, A. and Girolami, V. 2011. Lethal aerial powdering of honey bees with neonicotinoids from fragments of maize seed coat", Bulletin of Insectology, vol. 64, no. 1, pp. 119-126.

Matsuda, K., Kanaoka, S., Akamatsu, M., Sattelle, D.B., 2009. Diverse actions and terget-site selectivity of neonicotinoids: structural insights. Molecular pharmacology, 76(1): 1-10

Myers, J.P., vom Saal, F.S., Akingbemi, B.T., Arizono, K., Belcher, S., Colborn, T., Chahoud, I., Crain, D.A., Farabollini, F., Guillette, L.J. Jr., Hassold, T., Ho., S., Hunt, P.A., Iguchi, T., Jobling, S., Kanno, J., Laufer, H., Marcus, M., McLachlan, J.A., Nadal, A., Oehlmann, J., Olea, N., Palanza, P., Parmigiani, S., Rubin, B.S., Schoenfelder, G., Sonnenschein, C., Soto, A., Talsness, C.E., Taylor, J.A., Vandenberg, L.N., Vandenbergh, J.G., Vogel, S., Watson, C.S., Welshons, W.V., Zoeller, R.T., 2009a. Why public health agencies cannot depend on good laboratory practices as a criterion for selecting data: the case of bisphenol A. Environmental Health Perspectives, 117(3): 309-315.

Myers, J.P., vom Saal, F.S., Taylor, J., Akingbemi, B.T., Arizono, K., Belcher, S., Colborn, T., Chahoud, I., 2009b. Good laboratory practices: Myers et al. respond. Environmental health Perspectives, 117(11): 483-484.

Netherlands Health Council, 2000, Field research for the authorisation of pesticides. Health Council, The Hague. http://www.gr.nl/sites/default/files/00@07E.PDF

OECD, 2010. OECD Survey on pollinator testing, research, mitigation and information management : Survey results. OECD Series on pesticides, no. 52, 44 pp.

Pettis, J.S., vanEngelsdorp, D. Johnson, J. and Dively, G., 2012. Naturwissenschaften 99 (2) 153-158.

Simon Delso, N. 2010. Environmental Risk assessment. State of play and future proposals for honeybees. European Beekeeping Coordination, 38 pp.

Thompson, H.M. and Maus, C., 2007. The relevance of sublethal effects in honey bee testing for pesticide risk assessment. Pest Management Science, 63:1058-1061.

Thompson, H.M., 2010. Risk assessment for honey bees and pesticides – recent developments and "new issues". Pest Management Science, 66(11): 1157-1162.

Vidau C, Diogon M, Aufauvre J, Fontbonne R, Viguès B, et al. 2011. Exposure to Sublethal Doses of Fipronil and Thiacloprid Highly Increases Mortality of Honeybees Previously Infected by Nosema ceranae. PLoS ONE 6(6): e21550. doi:10.1371/journal.pone.0021550