Compilation of Recent Studies on Pollinators and Neonicotinoids
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July 2017

Brief summaries are provided below on recent research findings addressing the issue of pollinators and neonicotinoid insecticides ("neonics"), both from individual research projects (including a review on human health) as well as a list of review papers and reports in the following section.

Brandt, A., Gorenflo, A., Siede, R., Meixner, M., & Buchler, R. (2016). The neonicotinoids thiacloprid, imidacloprid, and clothianidin affect the immunocompetence of honey bees (Apis mellifera L.). *Journal of Insect Physiology, 86*, 40-47. Available from http://www.sciencedirect.com/science/article/pii/S0022191016300014

> This lab study of three neonicotinoids found that two (thiacloprid and imidacloprid) affected the immune systems (including blood cell densities) in honey bees at levels comparable to those found in the environment.

Christen, V., Mittner, F., & Fent, K. (2016). Molecular effects of neonicotinoids in honey bees (*Apis mellifera*). *Environmental Science & Technology*, *50*(7), 4071-4081. Available from http://pubs.acs.org/doi/abs/10.1021/acs.est.6b00678

> This lab and field study (in Switzerland) examining molecular effects found that acetamiprid (one of the neonics generally found to be less toxic than others) can still cause effects in honey bees, with potential for at least short-term impacts on behavior such as foraging.

Lentola, A., David, A., Abdul-Sada, A., Tapparo, A., Goulson, D., & Hill, E. (2017). Ornamental plants on sale to the public are a significant source of pesticide residues with implications for the health of pollinating insects. *Environmental Pollution, 228*, 297-304. Available from http://www.sciencedirect.com/science/article/pii/S0269749117305158

> This study in England examined pesticide residues on "bee-friendly" plants from garden centers, and detected neonics (including at levels sufficient to cause more subtle effects on bees) on over 70 percent of plants sampled.

Tosi, S., Burgio, G., & Nieh, J. C. (2017). A common neonicotinoid pesticide, thiamethoxam, impairs honey bee flight ability. *Scientific Reports, 7*(1), 1201. Available from http://www.nature.com/articles/s41598-017-01361-8

> This study involving an experimental "flight mill" reported that elevated exposure to one of the neonics (thiamethoxam) affected the ability of honey bees to fly, including the time and distance traveled.

Tsvetkov, N., Samson-Robert, O., Sood, K., Patel, H. S., Malena, D. A., Gajiwala, P. H., Maciukiewicz, P., Fournier, V., Zayed, A. (2017). Chronic exposure to neonicotinoids reduces honey bee health near corn crops. *Science, 356*(6345), 1395-1397. Available from http://science.sciencemag.org/content/356/6345/1395

> This study in Canada found negative impacts of one of the neonics (clothianidin) on bee colonies near corn fields. The study reported neonics were found at higher concentrations in

pollen from plants other than the treated corn, and two of the neonics were found to be twice as toxic to honey bees in the presence of a commonly used fungicide (boscalid), highlighting the importance of considering interactive effects of pesticides.

Woodcock, B. A., Bullock, J. M., Shore, R. F., Heard, M. S., Pereira, M. G., Redhead, J., . . . Pywell, R. F. (2017). Country-specific effects of neonicotinoid pesticides on honey bees and wild bees. *Science, 356*(6345), 1393-1395. Available from http://science.sciencemag.org/content/356/6345/1393

This study in three countries in Europe reported generally negative impacts on honey bees and wild bees in the U.K. and Hungary (and some positive impacts in Germany) associated with neonic use in nearby fields. In some cases (e.g. for solitary bees, and for queen production in bumble bees), the negative effects were seen with insecticides persisting over longer time periods.

Cimino, A. M., Boyles, A. L., Thayer, K. A., & Perry, M. J. (2017). Effects of neonicotinoid pesticide exposure on human health: a systematic review. *Environmental health perspectives, 125*(2), 155. Available from https://ehp.niehs.nih.gov/ehp515/

Though there has been limited research on threats to human health from neonics, a recent review noted that four general population studies found associations between chronic exposures to one or more neonics (or a degradation product) and developmental or nervous system impacts in people.

Recent Review Papers and Reports on Neonicotinoids and Impacts

Several recent reports and papers (and one older stakeholder report) addressing the issues of pollinator health more broadly and/or the role of insecticides in particular are listed here.

Epstein, D., Frazier, J., Purcell-Miramontes, M., Hackett, K., Rose, R., Erickson, T., Moriarty, T., & Steeger, T. (2013). USDA: Report on the National Stakeholders Conference on Honey Bee Health, available from https://www.usda.gov/sites/default/files/documents/ReportHoneyBeeHealth.pdf

Hopwood, J., Code, A., Vaughan, M., Biddinger, D., Shepherd, M., Black, S. H., Lee-Mader, E., & Mazzacano, C. (2016). How Neonicotinoids Can Kill Bees. *Xerces Society for Invertebrate Conservation, Portland, OR.* Available from http://xerces.org/neonicotinoids-and-bees/

IPBES (2016). The assessment report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services on Pollinators, Pollination and Food Production. S.G. Potts, V. L. Imperatriz-Fonseca, and H. T. Ngo, (eds). Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, Bonn, Germany. 552 pages. Available from http://nora.nerc.ac.uk/514356/

Lundin, O., Rundlof, M., Smith, H. G., Fries, I., & Bommarco, R. (2015). Neonicotinoid insecticides and their impacts on bees: A systematic review of research approaches and identification of knowledge gaps. *Plos One, 10*(8), 20. Available from http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0136928

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., Noome, D. A., Settele, J., Simon-Delso, N., Stark, J. D., Van der Sluijs, J. P., Van Dyck, H., Wiemers, M. (2015). Effects of neonicotinoids and fipronil on non-target invertebrates. *Environmental Science and Pollution Research, 22*(1), 68-102. https://link.springer.com/article/10.1007/s11356-014-3471-x

Sánchez-Bayo, F., Goka, K., & Hayasaka, D. (2016). Contamination of the aquatic environment with neonicotinoids and its implication for ecosystems. *Frontiers in Environmental Science, 4*, 71. Available from http://journal.frontiersin.org/article/10.3389/fenvs.2016.00071/full

Sheets, L. P., Li, A. A., Minnema, D. J., Collier, R. H., Creek, M. R., & Peffer, R. C. (2016). A critical review of neonicotinoid insecticides for developmental neurotoxicity. *Critical Reviews in Toxicology*, *46*(2), 153-190. Available from http://www.tandfonline.com/doi/abs/10.3109/10408444.2015.1090948

Simon-Delso, N., Amaral-Rogers, V., Belzunces, L. P., Bonmatin, J. M., Chagnon, M., Downs, C., Furlan, L., et al. (22 additional co-authors) (2015). Systemic insecticides (neonicotinoids and fipronil): trends, uses, mode of action and metabolites. *Environmental Science and Pollution Research, 22*(1), 5-34. Available from https://link.springer.com/article/10.1007/s11356-014-3470-y