Another Silent Spring?

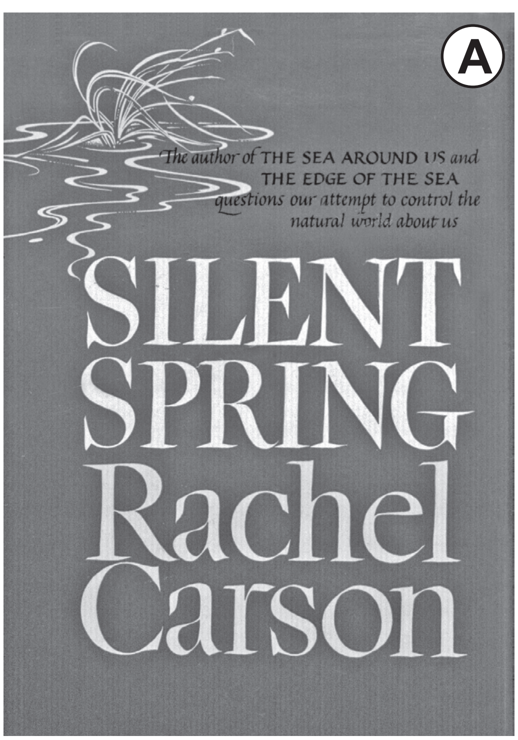
by Thomas D. Landis

The following is a expanded discussion on this article from the New Nursery Literature section: # 126 - Krischik V, Rogers M, Gupta G, Varshney A. 2015. Soil-applied imidacloprid translocates to ornamental flowers and reduces survival of adult *Coleomegilla maculata*, *Harmonia axyridis*, and *Hippodamia convergens* lady beetles, and larval *Danaus plexippu*s and *Vanessa cardui* butterflies. PLoS ONE 10(3): e0119133. doi:10.1371/journal.pone.0119133. 22 p.

#130. Worldwide integrated assessment of the impacts of systemic pesticides on biodiversity and ecosystems. Task Force on Systemic Pesticides. 2015. Environmental Science and Pollution Research 22:1-171.

My first exposure to the book *Silent Spring* was in a high school biology class and, if you have been following environmental issues, the term is back in the news (Bittel 2014; Montbiot 2014). *Silent Spring*, which was written by Rachel Carson in 1962 (Figure 1A), was concerned with the long-term environmental effects of the insecticide DDT. While the correlation between pesticide use and the environment was impossible to scientifically prove, DDT was finally banned by the US Environmental Protection Agency in 1972. One of the most serious environmental effects of DDT was bioaccumulation along food chains; the most famous and controversial was the weakening of egg shells of avian predators such as bald eagles, ospreys, and peregrine falcons. While difficult to prove experimentally, the effect became obvious when eagle populations became to steadily increase immediately after DDT was banned (Figure 1B). The population rebound has been especially obvious to us fishermen as we are seeing many, many more eagles and ospreys than we did when we were kids.

This new silent spring refers to the multiple adverse environmental effects of relatively new systemic insecticides known as neonicotinoids. Imidacloprid, the first commercially available "neonic" insecticide, has only been in use since the 1990s, but neonicotinoids are now the most widely used insecticides in the world. As they are water soluble, neonicotinoids are readily absorbed by plants via either their roots or



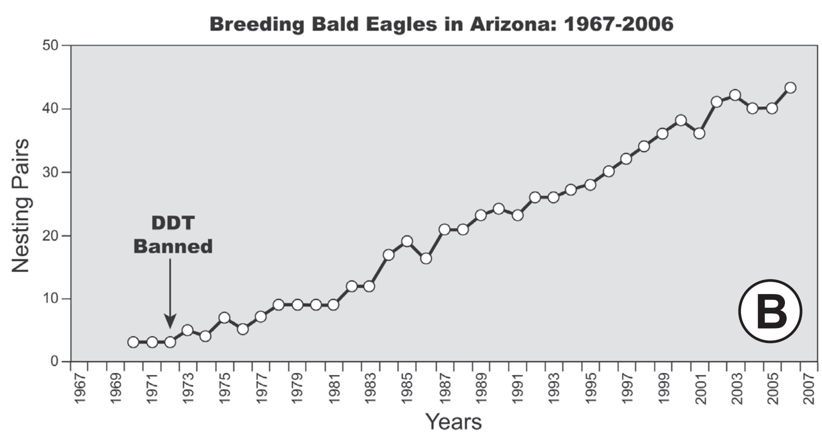


Figure 1 - Not only did Rachel Carson's book Silent Spring *(A) sound the alarm on the damage that DDT was causing to non-target organisms, but it helped launch the modern environmental movement. After the banning of DDT in 1972, bald eagle populations like these in Arizona began a population rebound that is evident today (B modified from Suckling and Hodges (2007).*

leaves and then readily transported throughout plant tissues. One major benefit of these pesticides is that they are effective at very low concentrations; 5 and 10 ppb (parts per billion) can provide protection against insect pests. So, in major agricultural crops, neonicotinoids are applied to seeds and then spread throughout the plant. Thus, they are even effective against boring and root-feedings insects that are impossible to reach with traditional insecticides. Although seed applications are most common, neonicotinoids have proven effective in a variety of other applications: soil drenches, injected into irrigation water, and even as sprays for homeowner use on flowers and vegetables (Goulson 2013).

Neonicotinoids were initially considered much safer than other pesticides due to their low toxicity to vertebrates. As with DDT, however, the evidence that neonicotinoids have been harming non-target organisms has been slowly accumulating primarily due to anecdotal observations that are hard to prove scientifically. A strong correlation has been noted between the use of neonicotinoid concentrations and the decline of bird populations in Europe (Hallman and others 2014). Being systemic, small concentrations of neonicotinoids are found in both pollen and nectar of treated crops that could have negative effects on pollinators, especially honey bees. The main concern is not direct toxicity but rather sublethal impacts that affect bee behavior. Compelling evidence has linked these insecticides to colony collapse disorder which drastically affected beekeepers around the world (Lu and others 2014). Neonicotinoids were also implicated in the low reproductive success of bumblebees (Laycock and others 2012). Most alarming, however, was the death of an estimated 50,000 bumblebees in Oregon from the non-label application of a neonicotinoid insecticide known as Safari (Black and Vaughan 2013).

What brings this issue home to nursery growers is the feature article showing that higher rates of soil-applied imidacloprid used in nurseries and greenhouses resulted in floral concentrations that were 793 to 1,368 times higher than that measured in seed treatments. A research trial showed that these higher insecticide levels caused significant mortality of 3 species of lady beetle and the caterpillars of two species of butterflies, including monarchs (Figure 2). While the caterpillar mortality is alarming, the more insidious threat is to beneficial insects which are critical to many integrated pest programs (Krischik and others 2015).

A recent review by a worldwide panel of scientists found that a compelling body of evidence has accumulated that

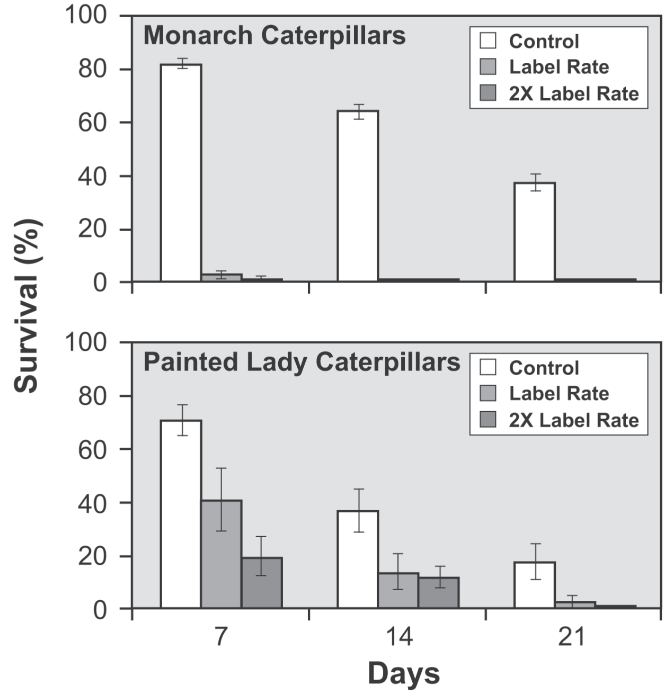


Figure 2 - Soil applications of a neonicotinoid insecticide (imidacloprid) at label rate (1X), or twice label rate (2X) significantly reduced the survival of the larvae (caterpillars) of two common butterflies (modified from Krischik and others 2015).

clearly demonstrates that these persistent, water-soluble chemicals are having widespread, chronic impacts upon global biodiversity and ecosystem services such as pollination. They urged an immediate reduction in the use of neonicotinoids and reversion to an Integrated Pest Management approach (van der Sluijs and others 2015). Countries of the European Union and Canada are vigorously attacking the problem, and it remains to be seen whether the US will follow suit.

"All the science is not done, but everything that I have before me. . . suggests to me that this is the biggest threat to the structure and ecological integrity of the ecosystem that I have ever encountered in my life, bigger than DDT" — Miller (2014)

"The systemic insecticides, neonicotinoids and fipronil, represent a new chapter in the apparent shortcomings of the regulatory pesticide review and approval process that do not fully consider the risks posed by large-scale applications of broad-spectrum insecticides to ecosystem functioning and services. **Our inability to learn from past mistakes is remarkable"** — van Lexmond and others (2015)

References

Bittel J. 2014. Second Silent Spring? Bird declines linked to popular pesticides. National Geographic, 9 Jul 2014. URL: http://news.nationalgeographic.com/news/2014/07/140709-birds-insects-pesticides-insecticides-neonicotinoids-silent-spring/ (accessed 11 Apr 2015).

Black SH. Vaughan M. 2013. Pesticide causes largest mass bumble bee death on record. URL:http://www.xerces.org/2013/06/21/pesticide-causes-largest-mass-bumble-bee-death-on-record/ (accessed 11 Apr 2015).

Goulson D. 2013. An overview of the environmental risks posed by neonicotinoid insecticides. Journal of Applied Ecology 50: 977–987.

Krischik V, Rogers M, Gupta G, Varshney A. 2015. Soil-applied imidacloprid translocates to ornamental flowers and reduces survival of adult Coleomegilla maculata, Harmonia axyridis, and Hippodamia convergens lady beetles, and larval Danaus plexippus and Vanessa cardui butterflies. PLoS ONE 10(3): e0119133. 22 p. doi:10.1371/journal.pone.0119133.

Laycock I, Lenthall KM, Barratt AT, Cresswell JE. 2012. Effects of imidacloprid, a neonicotinoid pesticide, on reproduction in worker bumble bees (Bombus terrestris). Ecotoxicology 21: 1937–1945.

Lu C, Warchol KM, Callahan RA. 2014. Sub-lethal exposure to neonicotinoids impaired honey bees winterization before proceeding to colony collapse disorder. Bulletin of Insectology 67: 125–130.

Miller G. 2014. Plight of the pollinators. In: Managing new challenges, annual report 2013/2014. Toronto (ON): Environmental Commissioner of Ontario. p 50–58. URL: http://www.eco.on.ca/uploads/Reports-Annual/2013-14/2014%20ar.pdf (accessed 5 May 2015).

Montbiot, G. 2014. Another silent spring? URL: http://www.monbiot.com/2014/07/15/another-silent-spring/ (accessed 5 May 2015).

Suckling K, Hodges W. 2007.Status of the bald eagle in the lower 48 states and the District of Columbia: 1963-2007. Tucson (AZ): Center for Biological Diversity. URL: http://www.biologicaldiversity.org/species/birds/bald_eagle/report/ (accessed 9 Apr 2015).

van der Sluijs JP, Amaral-Rogers V, Belzunces LP, and 27 others. 2015. Conclusions of the Worldwide Integrated Assessment on the risks of neonicotinoids and fipronil to biodiversity and ecosystem functioning. Environmental Science and Pollution Research 22:148–154.

van Lexmond MB, Bonmatin J-M, Goulson D, Noome, DA. 2015. Worldwide integrated assessment on systemic pesticides. Global collapse of the entomofauna: exploring the role of systemic insecticides. Environmental Science and Pollution Research 22:1–4.