How do pesticides affect pollinators?

Prof Jane Stout
Trinity College Dublin

stoutj@tcd.ie  @JaneCStout
Drivers of decline - Pollinators are exposed to multiple stresses...

- Climate (change & weather)
- Habitat loss
- Invasive species
- Competition
- Predators, parasites & disease
- Pesticides & pollution
- Naturally occurring toxins
- Management & trade
- Anthropogenic pressures
- Biological pressures
Pesticides use worldwide

3 main groups
Insecticides

Herbicides

Fungicides
Neonicotinoids

- Systemic pesticides
- Application and use:
  - Seed dressing – rape, cereals, maize, sunflower, beet
  - Sprayed on fruit crops
  - Soil drench or in granular form for pasture
  - Domestic use in gardens

Goulson 2013
Plant Protection Product (PPP) use in Irish agriculture

Area (000's ha) of application

- Grassland & Fodder
- Arable
- Vegetables
- Soft & top fruit

Categories:
- Herbicides
- Fungicides
- Insecticides
- Plant growth regulators
- Molluscicides
- Bio control

Delaney et al. in prep, from pesticide usage survey (DAFM)
Pesticide use in Irish agriculture

- Regulated by EU Directive on the sustainable use of pesticides (DIRECTIVE 2009/128/EC)
- PPPs – plant protection products
- National Action Plan
  - Reviewed at least every 5 years
  - Training, use (equipment, storage, supply, use in specific areas) & IPM
  - Pesticide usage survey

Zhao et al. 2013

Pesticide use outside agricultural settings
Exposure routes...  Depend on method of application and mode of action of pesticide

Direct – Spraying

Indirect – seed dressings, soil and water contamination...
> 80% of the tested soils contained pesticide residues

Silva et al. 2019 Science of the Total Environment 653: 1532–1545

All the sampled streams were contaminated with pesticides and, in most of the cases, veterinary drugs.

Casado et al. 2019 Science of the Total Environment 670: 204–1225
Residues in nectar and pollen of...

Flowering crops...

Wildflowers...

Horticultural plants...

Maize & dandelions: Krupke et al. 2012
OSR & wildflowers: Botías et al. 2015
Horticultural flowers: Lentola et al. 2017
Pesticides found in honey

Pesticides in 75% of honey samples

Pesticides in 77% of honey samples from 30 sites in Ireland
Kavanagh et al. (in prep)
What are the impacts of insecticide exposure?

- Soil and aquatic invertebrate mortality
  - Pisa et al. (2014)

- Bird decline
  - Hallaman et al. (2014)

- Widespread threat to wildlife and ecosystems
  - EASAC (2015)
Impacts of neonicotinoids on pollinators

- **Lethal effects**
  - Honeybees $LD_{50} = 4\text{ng (Imidacloprid)}, 27,000\text{ng (DDT)}$

- **Sublethal effects**
  - ↓ colony growth and queen production (Whitehorn et al. 2012 Science)
  - ↓ homing ability (Henry et al. 2012 Science)
  - ↓ worker production, ↑ worker mortality, ↓ pollen collection (Gill et al. 2012 Nature)
  - ↓ fecundity (Laycock et al. 2012 Ecotoxicology)…
• Insecticide treated crops reduced
  • wild bee density
  • solitary bee nesting
  • bumblebee colony growth and reproduction

Rundlöf et al. 2015. Nature 521:77-80

Web of Science “neonicotinoids and bees” (March 2019)
Effects of herbicides on pollinators

• Reduced food availability
• Direct toxicity low (WHO 1994)

• Affects honeybee navigation
  Balbuena et al. 2015. JEB 218:2799-2805.

• Affects honey bee gut bacteria & susceptibility to pathogens
Effects of fungicides on pollinators


• Effects on individual behaviour and colony success...
Synergistic effects


What is current situation in Ireland?

• Unknowns
  • Use
  • Quantity and persistence of residues
  • Exposure
  • Impacts of herbicides and fungicides

• Solutions
  • Research!
PROTECTS project

• Review of usage and soil risks
• Exposure levels in nectar and pollen (Elena Zioga, TCD) and soils (Mathavan Vickneswaran)
• Impacts of herbicides and fungicides on bumblebees at:
  • Molecular level (proteomics) (Merissa Cullen, UM)
  • Colony level (Linzi Thompson, UCD)
What can we do?

Increase awareness of impacts on bees and other wildlife

Reduce use, find alternatives

Change perceptions

www.pollinators.ie
How do pesticides affect pollinators?

❖ Through widespread exposure
❖ Lethal and sub-lethal effects
❖ Reduce, rethink, replace

stoutj@tcd.ie  @JaneCStout
www.campusbuzz.blog