SPRINT
SUSTAINABLE PLANT PROTECTION TRANSITION

RESEARCH PAPER SUMMARY

Selecting pesticides for ecological risk assessments of pesticide mixtures in soil

- **The environmental risks of individual pesticides may be greater when they mix with other pesticides.** Yet regulatory tests tend to focus on assessing the risks of pesticides in isolation.
- Researchers on the SPRINT project designed a practical new approach to support **ecological risk assessments of pesticide mixtures in soil**.
- There is **no need to assess every pesticide in a mixture**. The method allows regulatory scientists to identify which pesticides to include in tests.
- This factsheet presents this prioritisation approach, which is illustrated with scenarios that include **earthworms, bees, plants and microbes**.

This factsheet is based upon the following research paper:

Prioritization of currently used pesticides in soils of main European cropping systems and an Argentinian cropping system for assessment of mixture toxicity and risk on terrestrial biota. *Journal of Hazardous Materials*, 495, 138942. https://doi.org/10.1016/j.jhazmat.2025.138942

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This summary factsheet was edited by Michelle Kilfoyle.

https://sprint-h2020.eu

The research context

Stronger regulatory risk assessments for stronger environmental protection.

Regulatory safety tests of pesticides are strict. However, research shows that existing test methods may underestimate some risks – and potentially allow harmful products onto the market.

One of these risks is the potential toxic effects of **pesticide mixtures** to ecosystem health. Current regulatory tests tend to assess the risks of individual substances.

Mixtures accumulate in the environment, and can cause harm. For example, separate research from SPRINT shows that commonly found mixtures can kill earthworms, mites and bees, and reduce their rates of reproduction [*read a preview **here***].

Importantly, risks like these can occur even when the individual substances in a mixture are at **concentrations considered safe by regulatory tests**.

This highlights the need for regulators to start risk assessing more pesticide mixtures, as well as individual substances. However, it is unnecessary to assess every pesticide in a mixture. **A minority of pesticides are responsible for the majority of a mixture's toxicity.**

This new study provides **practical support for regulators**. It outlines an approach to help them narrow down the number of pesticides to test in mixtures by focussing on the ones that are most likely to cause harm.

Why are pesticide mixtures more harmful?

The toxicity of pesticide mixtures may be greater than suggested by the individual substances they contain for two reasons:

1. **Synergistic effects:** like chemicals in a test tube, pesticides in a mixture may react with one another and lead to new effects.
2. **Additive effects:** the very small, perhaps negligible, effects of each pesticide can add up and create larger, noticeable effects.

Method: the prioritisation approach

The SPRINT researchers followed the following steps to illustrate their approach for prioritising pesticides to include in **ecological safety tests on pesticide mixtures in soil.**

1. The researchers drew up a list of **73 pesticides** for assessment. These were all the currently approved-for-use substances they detected in soil samples gathered from various types of farmland across 10 European countries and Argentina. *[Note: more pesticides are likely to be in the soil samples but were not tested for]*.

2. The researchers then gave each of the 73 pesticides **a score based on its risk to 4 groups of organisms** that are *not* the intended target of the pesticide:

    1. **Soil invertebrates**: earthworms, springtails and soil mites.
    2. **Arthropods**: bees (honeybees, bumblebees and mason bees), a species of wasp and a species of mite.
    3. **Plants**
    4. **Microbes**

3. The score was based upon:
    1. each pesticide's **toxicity**
    2. **exposure** – how much contact the organism is likely to have with each pesticide
    3. **persistence** – how long the pesticide takes to degrade in soil – a measure of how long it stays active

4. The higher the score, the **greater the need to include the pesticide** in safety tests of mixtures.

5. Pesticides will vary by location and crop. The researchers produced a list of the **top 5 pesticides to test** in different cropping systems (e.g. vineyards, vegetables, orchards) in different countries.

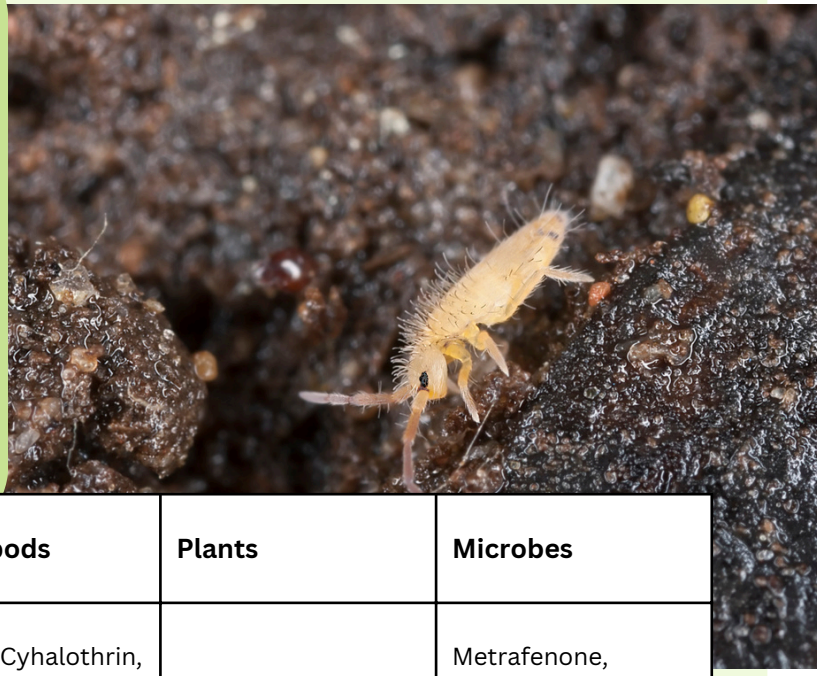
Not only soil: other exposure routes

This study provides a key part of the puzzle in understanding the overall risks of pesticides. However, it should be noted that the organisms studied generally come into contact with more pesticides elsewhere. For example, bees and other insects mainly encounter pesticides in the air and on plants (e.g. in contaminated pollen).

Results

For each of the 4 types of organism, the researchers selected **the 5 top pesticides to assess** in ecotoxicity tests of mixtures. These are the substances with the highest risk score.

The list of 5 varies according to **the crop and the location** from where the soil was gathered, as illustrated by the examples in the table below.



Cropping systems	Soil invertebrates	Arthropods	Plants	Microbes
Spain (Vegetables)	Oxyfluorfen, Chlorantraniliprole, Difenoconazole, Boscalid, Propyzamide	Lambda Cyhalothrin, Acetamiprid, Chlorantraniliprole, Glyphosate, Propamocarb (hydrochloride)	AMPA, Metazachlor, Propyzamide, Oxyfluorfen, Glyphosate	Metrafenone, Propamocarb (hydrochloride), Pendimethalin, Boscalid, Difenoconazole
France (Vineyards)	Chlorantraniliprole, Boscalid, Difenoconazole, AMPA, Cyflumetafen	Lambda Cyhalothrin, Trifloxystrobin, Spiroxamine, Metrafenone, Glyphosate,	AMPA, Glyphosate, Fenbuconazole, Difenoconazole, Metrafenone	Metrafenone, Boscalid, Glyphosate, Dimethomorph, AMPA
Switzerland (Orchards)	Difenoconazole, Methoxyfenozide, Myclobutanil, AMPA, Pirimicarb	Myclobutanil, Pirimicarb, Difenoconazole, Emamectin, Tebuconazole	AMPA, Difenoconazole, Myclobutanil, Emamectin, Tebuconazole	AMPA, Difenoconazole, Methoxyfenozide, Tebuconazole

Prioritised pesticides for three examples of cropping systems (note: AMPA is a breakdown product of Glyphosate). **For the full list of results, see:** **https://doi.org/10.1016/j.jhazmat.2025.138942**

Fungicides, herbicides and insecticides: which class of pesticide presents the greatest risks to which organisms?

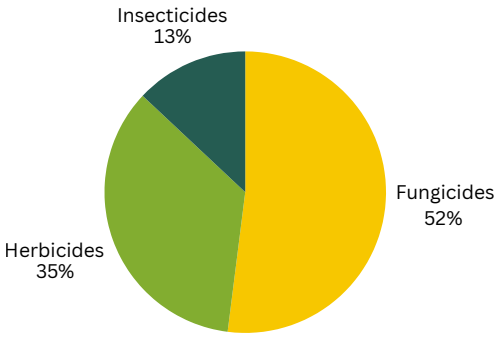
Results of the prioritisation scoring approach indicate that each class of pesticide can pose risks to completely different types of organism than those targeted. Fungicides - designed to control fungal infections, like mildew - can also harm insects and plants, for example.

Glyphosate results

A key result was that the herbicide glyphosate and/or its metabolite, AMPA, is of widespread concern to all 4 groups of organisms. Glyphosate is the most sold, and most used, broad-spectrum herbicide globally. Many studies have shown that it can be toxic to microbes, invertebrates, and insects.

Soil invertebrates

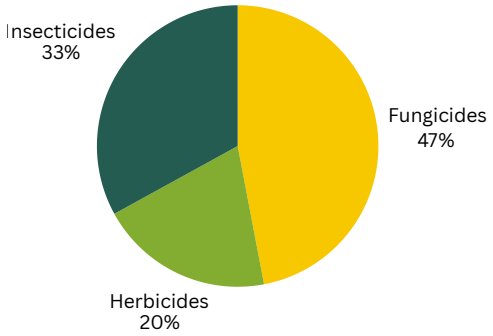
No. of priority substances identified: 23



Share of priority substances by class.

Arthropods

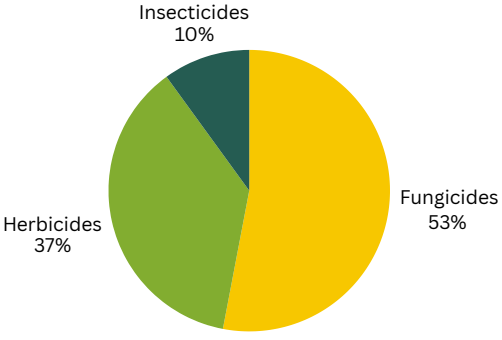
No. of priority substances identified: 30



Share of priority substances by class.

Plants

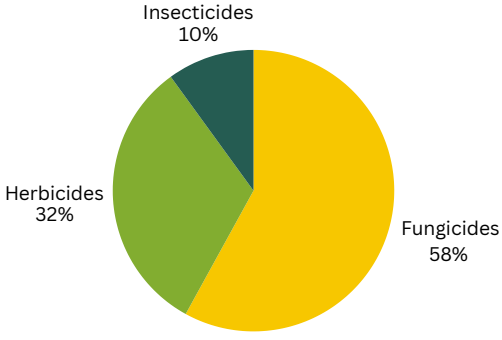
No. of priority substances identified: 30



Share of priority substances by class.

Microbes

No. of priority substances identified: 19



Share of priority substances by class.

Summary and recommendations

This study from SPRINT provides a new approach for evaluating the risks to biodiversity of pesticide-contaminated soil.

Risk assessing mixtures
By focusing on pesticide mixtures, the approach allows assessors to better capture real-world environmental risks posed by pesticides. In turn, this will support stronger protection of the environment.

By identifying priority substances to test, the approach is practical and efficient.

SPRINT's tests that use the approach show that soil invertebrates and insects are vulnerable to all classes of pesticide (herbicides, fungicides and insecticides). This supports the case for testing all pesticides on a range of non-target organisms, regardless of the organism they are designed to control.

Environmental monitoring
The approach can further enhance environmental monitoring programmes by identifying which pesticides to focus on in major cropping systems to address risks to soil invertebrates, beneficial insects, plants and microbes.

Want to know more?

Read the full research paper:
Prioritization of currently used pesticides in soils of main European cropping systems and an Argentinian cropping system for assessment of mixture toxicity and risk on terrestrial biota. *Journal of Hazardous Materials*, 495, 138942. https://doi.org/10.1016/j.jhazmat.2025.138942

Any questions?

Contact the study's lead authors:
Olukayode Jegede: ojegede@ucdavis.edu
Paula Tourinho: paula.tourinho@recetox.muni.cz

About SPRINT

SPRINT is a 5-year international research project. It investigates pesticides' risks to health and the environment, and aims to accelerate the transition towards more sustainable plant protection.

https://sprint-h2020.eu

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