agrar
agrar-industrie.ch

Explanation of terms relating to two anti-pesticide initiatives

Pesticides, crop protection products, biocides

March 2019

Two popular initiatives attacking pesticides were proposed in 2018. These are the initiative 'For clean drinking water and healthy food – No subsidies for pesticides and the prophylactic use of antibiotics' and the initiative 'For a Switzerland without synthetic pesticides'. The Federal Council has rejected both initiatives without making a counter-proposal. The Swiss Farmers' Association and the business community also firmly reject the initiatives. They are detrimental both to regional agricultural production and to Switzerland as a centre of industry and research. They also threaten consumers' interests in obtaining high-quality and affordable food. The initiatives give rise to various questions about the terms involved. What exactly are synthetic pesticides? This paper helps clarify the confusion surrounding the concepts.

Crop protection is a science. And a science relies on precise definitions of terms, which are also used internationally. If an initiative proposes writing a ban on 'synthetic pesticides' into the constitution, there must be clarity about what this term really means. In its statement, the Federal Council also took a close look at the terms of the initiative.

What are pesticides?

According to the official definition used by the World Health Organization (WHO) and the Food and Agriculture Organization of the United Nations (FAO), a pesticide means any substance, or any mixture of substances consisting of chemical or biological ingredients, intended for repelling and combating pests, diseases and weeds as well as plant growth regulators. Pesticides can be classified as follows:

- **Crop protection products** (products for protecting plants)
  e.g. fungicides, which are fungal control agents
- **Biocides** (products for protecting humans and animals)
  e.g. cleaning agents and disinfectants

This definition also corresponds to the definitions of pesticides and crop protection products in European legislation (EFSA, EU Directives). Any reference to pesticides therefore always encompasses both crop protection products and biocides. A ban on pesticides also means a ban on the use of cleaning agents and disinfectants.

What are crop protection products?

Crop protection products are chemical and biological active substances or preparations used to protect plants and plant products against harmful organisms, to regulate the metabolism and growth of plants and to destroy unwanted plants or parts of plants. Crop protection products are divided into different groups according to their effect. For example:

- **Herbicides:** weed control agents

- **Insecticides**: insect control agents
- **Fungicides**: fungal disease control agents
- **Molluscicides**: snail repellents
- **Growth regulators**: agents for regulating biological processes

What are biocides?

Biocides are active substances or preparations that kill harmful organisms or at least restrict their vital functions. They are used, for example, to combat bacteria, insects, fungi and algae. Harmful organisms can be controlled by chemical or biological means. Biocides can be roughly divided into four main groups:

- **Disinfectants**: e.g. for human or veterinary hygiene, but also products used to disinfect drinking water
- **Protective agents**: e.g. wood preservatives, sprays against mosquitoes or impregnating agents for building materials
- **Pest control agents**: insecticides, acaricides (to control mites and spiders), rodenticides (to combat rodents), etc.
- **Other biocide products**: e.g. anti-fouling agents that prevent organisms from colonising the hulls of ships

What is an active substance?

Active substances are biologically active compounds which, in low concentrations, influence biochemical and physiological processes in plant, animal and human organisms quantitatively and/or qualitatively in the form of inhibition or activation.

What are synthetic pesticides?

All pesticides that are produced by synthesis are synthetic. Synthesis is the process by which a compound is produced from elements or a new substance is produced from simple compounds.

Two types of synthetic pesticide can be distinguished:

- **Synthetic pesticides that are nature-identical**. One example is pheromones. Insect pheromones are messenger substances that serve as a means of chemical communication between individuals of an insect species. Agriculture uses insect pheromones in pest control in the form of pheromone traps that prevent egg deposition and in the use of mating disruption. Pheromones used commercially are synthesised. The compounds produced in the laboratory have the same molecular structure as naturally occurring substances.
- **Synthetic pesticides that are not nature-identical**. These are compounds that do not occur in nature. One example from the field of medicine is aspirin. This compound is produced through chemical synthesis. Aspirin does not occur in nature in this way. However, it is a very helpful remedy. Not many people want to do without the achievements of modern medicine, which include synthetic drugs and vaccines.

Which pesticides are non-synthetic?

Non-synthetic pesticides include:

- organisms such as bacteria, viruses and fungi,
- alumina widely found in nature,
- non-chemically modified substances obtained by physical processes (extraction, pressing, distillation, etc.) from seeds, plants, bacteria, fungi and petroleum.

Do organic farmers also use synthetic pesticides?

Yes, they do (see Table 1). For example: none of the copper salts permitted in organic crop protection are obtained directly from natural sources. They are produced synthetically. Sulphur does not usually come from a natural source either but is produced synthetically. Potassium bicarbonate, potash soap and iron phosphate are also considered synthetic pesticides. In contrast to other active substances, these agents are usually produced via inorganic synthesis methods. Many organic pesticides also contain auxiliary substances and additives which are also synthetic. One example: in order for sulphur to be used as a pesticide at all, it must be formulated in an aqueous suspension (sulphur is not water-soluble). Synthetic dispersing agents (e.g. lignosulphonates) are used for this.

Are synthetic pesticides fundamentally more problematic?

No, they are not. Whether or not a pesticide is synthetically produced does not say anything about its toxicological properties (toxicity). Aflatoxins are among the strongest carcinogens known to man. As fungal toxins they are completely natural. And the most poisonous of all substances, botulinum toxin, is also brewed by Mother Nature without any human interference. Therefore, even organic pesticides are not fundamentally harmless. For example, a large proportion of the copper preparations that are frequently used in organic farming to protect fruit, vines and potatoes are classified as harmful to health and the environment. The insecticide pyrethrum, which is extracted from the flowers of various plant species, kills bees that come into direct contact with it. The pyrethrins contained in the pyrethrum extract are nerve toxins that can also attack the human central nervous system. Paraffin oil can be fatal if swallowed or if it enters the respiratory tract. Lime sulphur can irritate the air passages and cause allergic skin reactions. Over 40% of the approximately 2,000 tons of pesticides sold in Switzerland are organic, and this proportion is increasing. About 70 tons of copper alone are sold in Switzerland every year.

Is there a need for synthetic pesticides at all?

Yes, because synthetic agents have great advantages over natural agents in terms of production and durability. They also act more specifically and precisely.

- **Synthetic substances can be produced in the laboratory with the desired properties and in the required quantities, while there are limits to active substances obtained from nature.** After the discovery of a substance that demonstrates desired biological activity, the problem often arises that it can only be obtained from natural sources in small quantities and sometimes by using highly complex methods. A well-known medical example is the effective anti-tumour drug paclitaxel, which is extracted from the bark of the Pacific yew (Taxus brevifolia). The demand for paclitaxel by far exceeds the amount that can be extracted from the trees, as extraction can only take place by killing the tree, and the trees grow very slowly. Some naturally occurring substances that are used as pesticides (e.g. insect pheromones) are synthetically produced for this very reason: the demand for them exceeds their availability in nature. In other cases, the natural availability of a substance is artificially increased. For example, chrysanthemums are cultivated in large-scale monocultures to obtain sufficient quantities of the insecticide pyrethrum, which is approved for organic farming. Most of this production takes place in Africa (Kenya, Tanzania, Rwanda) and Croatia. In most cases, these chrysanthemums are not cultivated organically. This type of production is far from being sustainable.
- **Synthetic pesticides are generally more stable.** They are not as sensitive to light or oxygen. They adhere to and remain on the plants for longer. This allows them to exert their effect over a longer period of time without repeated application. Unnecessary tractor movements are thus prevented, which is also important because tractors compact the soil and emit CO_2.

- **Synthetic pesticides are generally more effective and for more specific uses.** Recent decades have seen a dramatic reduction in the amount of active substances applied per hectare:[1] the rate of pesticide application per hectare has fallen by 95% since 1950, which means that farmers have to apply much lower doses to achieve the same level of effectiveness. In addition, the amount of food produced from each ton of active substance used has increased by more than 10% since 1980. This means that one hectare of agricultural land today feeds an average of 155 people, compared with four people per hectare in 1900.[2] Meanwhile, new active substances have become safer. Their average acute toxicity has decreased by 40% since the 1960s.

What is meant by integrated crop protection?

Chemical control measures are only used if preventive, non-chemical measures cannot ensure the adequate protection of crops against harmful organisms. If the use of pesticides is necessary, measures are taken to mitigate the risks. Chemical measures refer to treatment with chemical substances and substance mixtures. Chemical control measures are also permitted in organic farming (e.g. treatment of plants with copper salts, sulphur, pyrethrum, etc.).

[1] 2018 - Phillips McDougall, Evolution of the Crop Protection Industry since 1960.
[2] https://www.rlv.de/presse/beitrag-presse/detail/ein-landwirt-ernaehrt-heute-155-mitbuerger/; https://www.schweizerbauer.ch/politik--wirtschaft/agrarpolitik/ein-landwirt-ernaehrt-durchschnittlich-155-menschen-33043.html

Table 1. Detailed information about the production of some organic pesticides

- **Copper sulphate**: is produced from copper oxide or copper sulphide and sulphuric acid

  $CuO + H_2SO_4 \rightarrow CuSO_4 + H_2O$
  $CuS + H_2SO_4 \rightarrow CuSO_4 + H_2S$

- **Copper oxychloride**: is synthesised through the electrochemical reduction of copper(II) chloride in a concentrated sodium chloride solution with copper metal, followed by oxidation with oxygen

  $CuCl_2 + Cu + 2\ NaCl \rightarrow 2\ NaCuCl_2$
  $6\ NaCuCl_2 + 3/2\ O_2 + H_2O \rightarrow CuCl_2 \cdot 3\ Cu(OH)_2 + 2\ CuCl_2 + 6\ NaCl$

- **Copper hydroxide**: is produced through the reaction of copper sulphate with caustic soda

  $CuSO_4 + 2\ NaOH \rightarrow Cu(OH)_2 + Na_2SO_4$

- **Sulphur**: is mostly produced as a waste product in the desulphurisation of crude oil and natural gas

  $2\ H_2S + 3O_2 \rightarrow 2\ SO_2 + 2\ H_2O$
  $2\ H_2S + SO_2 \rightarrow 3\ S + 2\ H_2O$

- **Potassium bicarbonate**: is synthesised from potassium carbonate and water

  $K_2CO_3 + H_2O \rightarrow KHCO_3 + KOH$

- **Iron phosphate**: is produced from iron hydroxide and phosphoric acid

  $Fe(OH)_3 + H_3PO_4 \rightarrow FePO_4 + 3\ H_2O$

- **Potash soap**: is produced by saponifying linseed oil with potassium hydroxide. Saponification is the hydrolysis of an ester by an aqueous hydroxide solution, such as potassium hydroxide, or by special enzymes. It is considered an organic synthesis process.