



Clopyralid damaged tomato

PESTICIDES IN ORGANIC FERTILISERS AND SOIL

Experiences from the 2021 growing season in Sweden

As early as 2020, Fritidsodlingens Riksorganisation (Swedish Leisure Garden Association), FOR, stated that several organic fertilizers based on vinasse, a residual product from sugar production, were contaminated with the pesticide clopyralid (Nilsson 2021). A substance that, even at very low concentrations, parts per billion, can damage sensitive plants and cause malformed stems, leaves and fruits. Clopyralid, and the closely related substances aminopyralid and picloram, are herbicides within the group of pyridine carboxylic acids, which are used to kill herbaceous broad-leaved weeds in cereals, grasslands, oilseeds and sugar beet fields. They are significantly more persistent than most other plant protection products that are approved in Sweden. For example, the half-life in soil may be over 500 days for aminopyralid and picloram, and 250 days for clopyralid.

The problem with the contaminated plant fertilisers in 2020 was traced back to weed control, using clopyralid, in sugar beet fields in France, Germany and Poland. It was also found in Denmark, Norway and Finland that vinasse-based organic fertilisers intended for private consumers could contain residues of clopyralid (Haveselskabet 2021; McKinnon et al. 2021). The attention meant that several of the large Swedish retailers stopped selling fertilisers based on vinasse and manufacturers withdrew products from the market. Unfortunately, in the spring of 2021, reports continued to come in to FOR from gardeners who suspected that their plants had been damaged by herbicides. FOR therefore decided to continue collecting information from affected gardeners via an online survey and to carry out analyses and cultivation experiments.

* In this report, the term pyridine is used throughout to facilitate reading, which then refers to clopyralid, aminopyralid and picloram together. When the description only applies to one of the substances, the full name is written.

RESULTS AND DISCUSSION

Survey

A total of 124 responses were received and 83% of the respondents stated that they had never before noticed similar symptoms on their cultivated plants. Those who responded to the survey were primarily residents of Skåne Region, the west coast and the Greater Stockholm area. Approximately one third of the respondents suspected that the damage was caused by locally produced manure, straw or silage (Figure 1). A total of 23% stated that the damage was probably caused by horse manure, followed by sheep manure, 3%, and chicken manure, 2.4%.

The growers who suspected that their crops were damaged by contaminated manure or straw from local horse stables and farms were mainly located in southern Sweden and around Stockholm. A quarter reported purchased peat based potting soil, and less than a fifth purchased organic plant fertilisers in liquid or solid form, as a possible cause of contamination.

Regarding purchased potting soil and fertiliser products, there were 11 different brands that were suspected of being contaminated and having caused plant damage. Tomatoes, peppers and chilies were plants that were reported to have suffered the most damage during the growing season in 2021. This was followed by beans and peas. Among other affected plants were dahlia, cucumber, phyllis, squash and potatoes.

Analyzes

To investigate whether it was really clopyralid, aminopyralid or picloram that caused the plant damage, 32 analyzes were performed on organically based plant nutrition products and potting soils available on the Swedish consumer market. Horse manure and sheep manure used in three different allotment sites in Stockholm that had caused severe plant damage were also analyzed, as well as leaves and fruit of tomato and potatoes that were suspected of being damaged by the manure. Four gardeners also sent in samples of horse manure, chicken manure, silage and straw.

The samples were analyzed for the content of four different herbicidal products belonging to the pyridine carboxylic acids; aminopyralid, clopyralid, fluroxypyr, and picloram. The analyzes were based on high-performance liquid chromatography coupled with liquid chromatography-tandem mass spectrometry (LC-MS/MS).

Nine out of seventeen plant nutrients analyzed contained residues of the herbicide clopyralid and/or aminopyralid (Table 1). The concentration in the products varied between 12-800 µg/kg. There are several brands that have been contaminated and which are based on different types of organic raw material. In addition, several of the products consisted of two or more types of organic raw materials, which makes it difficult to deduce the actual source of contamination. The highest levels of clopyralid were measured in two liquid fertiliser

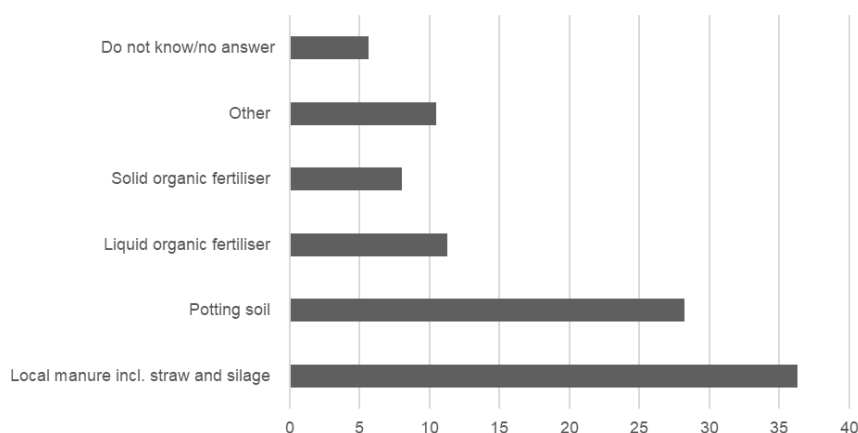


Figure 1. Stated suspected source of herbicide contamination (%), based on 124 responses.

products: Green Future Organic Tomato Fertiliser and Neudorff Effekt Kryddnäring (fertiliser for herbs), both of which contained sugar beet extract, and in Substral cow manure. Aminopyralid was found in two products. Three manure products based on chicken manure contained clopyralid, two of which are based on Swedish chicken manure.

No pesticide residues could be detected in the examined potting soils (Table 2). However, one producer has informed that they had problems with clopyralid in soil products during the season (Hasselfors Garden 2021).

Clopyralid and picloram were detected in horse manure used on an allotment area in Stockholm. Clopyralid was also detected in tomato leaves and fruit fertilized with the same horse manure in the allotment area.

However, the analysis could not detect pyridine residues in potatoes from the same site even though they were clearly malformed. The sheep manure that caused damage in two allotment sites contained amino- and clopyralid (Table 3). An estimated 50 allotmenters had crops destroyed by contaminated horse manure and around 40 allotmenters by sheep manure. Traces of clopyralid were found in a sample of a mixture of chicken droppings and straw sent in by a gardener having chickens in the garden. In other samples of horse manure, soil, straw and silage, the analysis results were negative, although images of plants fertilized with these showed damage that was probably caused by herbicides. Fluroxypyr was not detected in any of the samples.

Table 1. Results of pyridine analysis of organic based plant fertiliser. KRAV is a Swedish ecolabel. *Note that liquid fertilisers are diluted before usage which affect the actual amount of pyridine residuals applied to plants. ND = Not detected.

Product	Type of product	Ingredients (fertiliser)	Ecolabeled	Aminopyralid	Clopyralid	Picloram	Fluroxypyr
Hasselfors Garden Gödsel för frukt och bär (fertiliser for fruit and berries)	Solid fertiliser	Residues from animal and plants (sea weed, cacao, vinasse, molasses, bone meal)	KRAV	ND	ND	ND	ND
Neudorff Effekt trädgårdsgödning (garden fertiliser)	Solid fertiliser	Raw material of animal and plant origin	KRAV	ND	125 µg/kg	ND	ND
Solabiol Tomatgödsel (tomato fertiliser)	Solid fertiliser	Raw material of animal origin, plant compost	EU Organic	ND	ND	ND	ND
Stroller Tomatgödsel (tomato fertiliser)	Solid fertiliser	Raw material of animal origin, plant compost	EU Organic	ND	26 µg/kg	ND	ND
Substral Grönsaksgödsel (vegetable fertiliser)	Solid fertiliser	Raw material of plant origin (molasses, vinasse, malt sprouts)	KRAV	ND	ND	ND	ND
Emmaljunga Höns gödsel (chicken manure)	Solid fertiliser	Chicken manure	No	ND	96,2 µg/kg	ND	ND
Hasselfors Garden höns gödsel (chicken manure)	Solid fertiliser	Chicken manure	No	ND	102 µg/kg	ND	ND
Rölunda Höns gödsel (chicken manure)	Solid fertiliser	Chicken manure	No	ND	ND	ND	ND
Substral Höns gödsel (chicken manure)	Solid fertiliser	Chicken manure	No	ND	12 µg/kg	ND	ND
Södra Årshults Torv Höns gödsel (chicken manure)	Solid fertiliser	Chicken manure	No	ND	ND	ND	ND
Engeltorp, Kogödsel 40% (composted cow manure 40%)	Solid fertiliser	Cow manure	No	ND	ND	ND	ND
Fagerhultstorv AB, Kogödsel 80% (composted cow manure 80%)	Solid fertiliser	Cow manure	No	ND	ND	ND	ND
Plantagen Kogödsel (cow manure compost)	Solid fertiliser	Peat, cow and chicken manure	No	ND	ND	ND	ND
Substral Kogödsel (cow manure)	Solid fertiliser	Dried cow manure	KRAV	172 µg/kg	447 µg/kg	ND	ND
Algomin*	Liquid fertiliser	Algae, maize starch	KRAV	155 µg/kg	ND	ND	ND
Green Future Organic Tomato Fertiliser*	Liquid fertiliser	Sea weed, unspecified organic material	No	ND	800 µg/kg	ND	ND
Neudorff Effekt Kryddnäring (fertiliser for herbs)*	Liquid fertiliser	Extract from sugarbeets	KRAV	ND	667 µg/kg	ND	ND

Table 2. Results of pyridine analysis of potting soils. KRAV is a Swedish ecolabel. ND = Not detected.

Product	Type of product	Ecolabel	Aminopyralid	Clopyralid	Picloram	Fluroxypyr
Blomsterlandet Tomatjord PRO	Potting soil	KRAV	ND	ND	ND	ND
Emmaljunga Exklusiv Plantjord för ekologisk odling	Potting soil	KRAV	ND	ND	ND	ND
ICA Garden Blomjord	Potting soil	KRAV	ND	ND	ND	ND
Simontorp Blomjord	Potting soil	KRAV	ND	ND	ND	ND
Södra Årshults Torv Grönsaksjord	Potting soil	KRAV	ND	ND	ND	ND
Änglamark Blomjord	Potting soil	KRAV	ND	ND	ND	ND
Hasselfors Garden Naturgödsblad såjord	Seed starting mix	KRAV	ND	ND	ND	ND
Simontorp Såjord med perlite	Seed starting mix	KRAV	ND	ND	ND	ND
Änglamark Såjord	Seed starting mix	KRAV	ND	ND	ND	ND
Engeltorp planteringsjord	Potting soil	No	ND	ND	ND	ND
Gardol Planteringsjord	Potting soil	No	ND	ND	ND	ND
Hasselfors Garden P-Jord	Potting soil	No	ND	ND	ND	ND
Plantagen Premiumjord	Potting soil	No	ND	ND	ND	ND

Table 3. Results of pyridine analysis of manure, straw, silage and plants. ND = Not detected.

Sample	Location	Aminopyralid	Clopyralid	Picloram	Comment
Horse manure	Pungpinan allotments, Stockholm	ND	466 µg/kg	8,9 µg/kg	Not completely decomposed manure from local riding stable. The stable used peat as bedding material. Therefore clopyralide and picloram most likely originate from winter fodder. The manure damaged 50 allotment plots.
Tomato leaves	Pungpinan allotments, Stockholm	ND	102 µg/kg	ND	Fertilised with horse manure from Pungpinan. Analysed plant showed typical symptoms of herbicide damage.
Tomato fruit	Pungpinan allotments, Stockholm	ND	109 µg/kg	ND	Fertilised with horse manure from Pungpinan. Analysed plant showed typical symptoms of herbicide damage.
Potatoes	Pungpinan allotments, Stockholm	ND	ND	ND	Fertilised with horse manure from Pungpinan. Analysed plant showed typical symptoms of herbicide damage.
Sheep manure	Gubbängen and Årstafältets allotments, Stockholm	17 µg/kg	9,4 µg/kg	ND	Sheep manure from small-scale local farm. Winter fodder bought from conventional farm north of Stockholm. The manure damaged 40 allotment plots
Mix of straw and chicken droppings	Skåne	ND	29,6 µg/kg	ND	Straw not treated with herbicides from pyridine group according to farmer. Chicken fodder likely source of contamination.
Greenhouse soil added with chicken dropping, organic bedding material and straw.	Skåne	ND	ND	ND	In cultivation test soil mixture caused typical herbicide damage on field bean.
Horse manure	Skåne	ND	ND	ND	Horse fodder contained cereals treated with Ariane (herbicide based on clopyralid, MCPA and fluroxypyr). Fertilised tomato showed typical symptoms of herbicide damage.
Top soil mixed with silage and horse manure	Skåne	ND	ND	ND	Fertilised tomato showed typical symptoms of herbicide damage
Horse manure	Dalarna	ND	ND	ND	Fertilised jerusalem artichoke showed typical symptoms of herbicide damage
Silage	Dalarna	ND	ND	ND	Fertilised jerusalem artichoke showed typical symptoms of herbicide damage
Horse manure (undecomposed)	Stockholm	ND	ND	ND	Horses grazing on summer pasture. Herbicide damage not expected.

Cultivation experiments

A simple cultivation test examined whether the plant fertiliser, where the analyzes showed the presence of pyridine, also caused damage to bean plants. A total of nine products and an untreated control group were included. Plant damage to foliage was assessed visually after four weeks based on a modified experimental protocol from Washington State University (2002). The damage grading is based on a scale from 0 to 3 where 0 corresponds to no damage and 3 severe damage in the form of twisted stems (epinasty) and that most of the leaves in the top shoots are deformed.

Injury symptoms appeared in all treatments except for Algomin and the control group. Three of the products; Emmaljunga chicken manure, Hasselfors chicken manure and Stroller tomato manure resulted in only minor changes in leaf shape that most gardeners had probably not noticed. The most severe damage was caused by Green Future Organic and two products from Neudorff.

CONCLUSION

Auxin-mimic pyridine substances have now been found in almost all organic raw materials, originating in agriculture, used by gardeners as plant fertilisers. Residues of clopyralid have been found in cow-, horse-, sheep- and chicken manure as well as in sugar beet extracts, aminopyralid in maize starch and cow manure, and picloram in horse manure. It can affect gardeners who buy organic plant fertilisers at garden centers as well as those who pick up manure, straw or silage from horse stables or local farms. Not even gardeners who use chicken manure from their own chickens, fed with purchased feed, can with certainty avoid getting plant damaged. Furthermore, the extremely low amount of pyridine required to cause damage to sensitive plants make it very difficult for organic fertiliser manufacturers to handle.

The extent of the problem shows that it is a matter of system error, which allow these herbicides to be used in agriculture without at the same time ensuring that they do not cause damage at a later stage of cultivation in recreational gardens. This is not primarily due to a lack of supervision on the part of individual farmers.

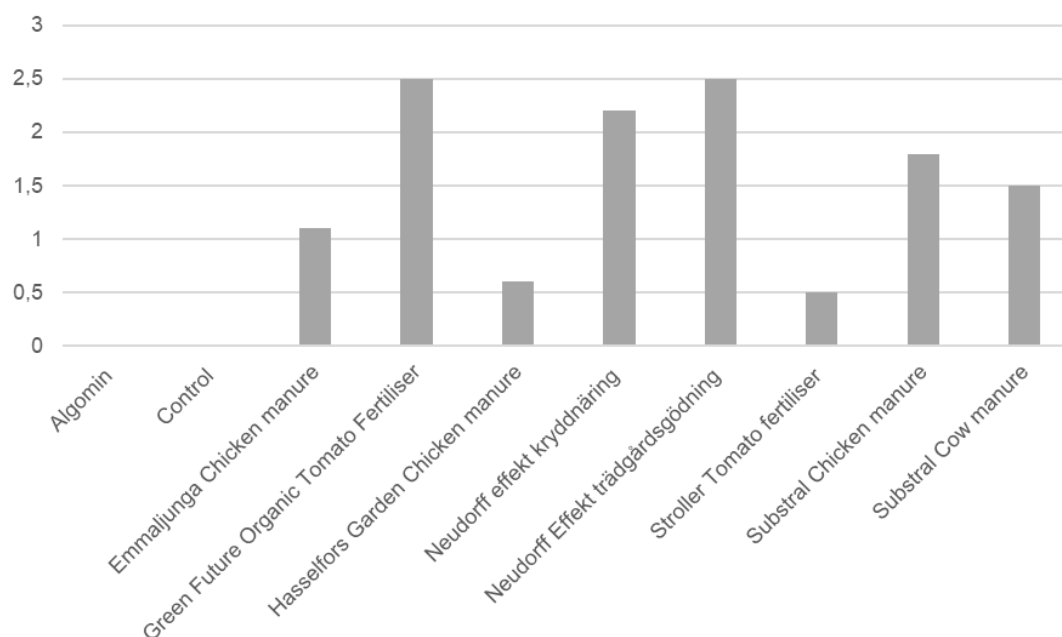


Figure 2. Assessment of plant damage caused by pyridine residues in organic plant fertilisers. Grading from 0 to 3 where 0 equals no damage and 3 severe damage (n=8 for solid fertilisers and n=6 liquid fertilisers).

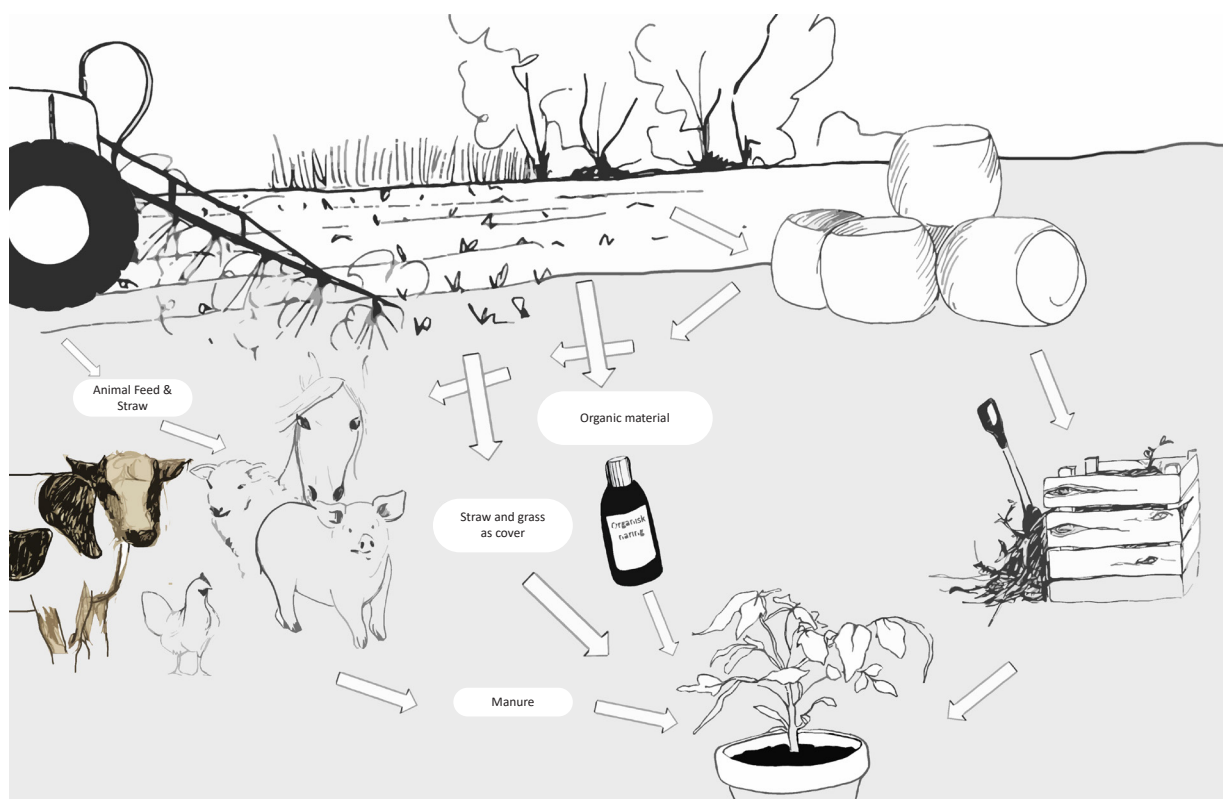


Figure 3. Examples of possible pathways that could bring picloram, amino- and clopyralid to your garden and plants.
Illustration Emma Franzén.

In addition to the herbicides destroying tens of thousands of plants for great economic value, it has also led to anxiety and reduced joy of cultivation for those affected. Many people are worried about how long the soil will be contaminated and when they can dare to grow on the contaminated site again (Nilsson 2021). But even more serious is that the gardeners trust in organic fertilisers has been severely damaged which is a threat to increased circular bioeconomy in gardening. No producers or horse stables today dare to give guarantees that the plant fertiliser or manure is free from amino- and clopyralid or closely related substances (Holmberg 2021; Vestin 2021). A prerequisite for a functioning circular economy is that the cycles are not contaminated by harmful chemicals (Swedish Government Offices 2020).

According to EU- regulation 1107/2009, article 4 and paragraph 3C “a plant protection product shall not have any unacceptable effects on plants or plant products”. We believe that the content of

this report shows that herbicides based on picloram, amino- and clopyralid do not fulfill this statement.

We therefore wonder

Have these negative side-effects of picloram, amino- and clopyralid for recreational gardeners been noticed and considered when the Standing Committee on Plants, Animals, Food and Feed, SCoPAFF, has approved these substances? If the answer is yes, on what grounds were these effects classified as acceptable?

What action will the SCoPAFF take to make sure that the recreational gardeners in Europe (5 million in Sweden alone) safely can use organic fertilisers and manure knowing that these products do not contain any of the harmful substances?

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