

Understanding Persistent Herbicides



US Composting Council®

www.compostingcouncil.org

Approximately 15 years ago, composters became aware that a certain class of weed killers was showing up in finished compost in a way that affected some plants. Our industry has named them “**Persistent Herbicides.**” Chemically, these weed killers are picolinic acids designed to target many broadleaf plants. Composters have come to understand that concentrations as low as one part per billion (ppb) may negatively affect some plants. Feedstocks that arrive to your facility may have unacceptably high concentrations of Persistent Herbicides even years after a person applies these herbicides to vegetation. Composters must educate themselves, but at the same time, chemical manufacturers will develop new products, reformulate existing products, and apply for supplemental labeling that allows use in new ways at new areas. Such changes may contaminate other feedstocks in new areas and may require new detection methods. This fact sheet is the first in a series intended to help the composting industry understand and cope with Persistent Herbicides. The other two fact sheets in the series are:

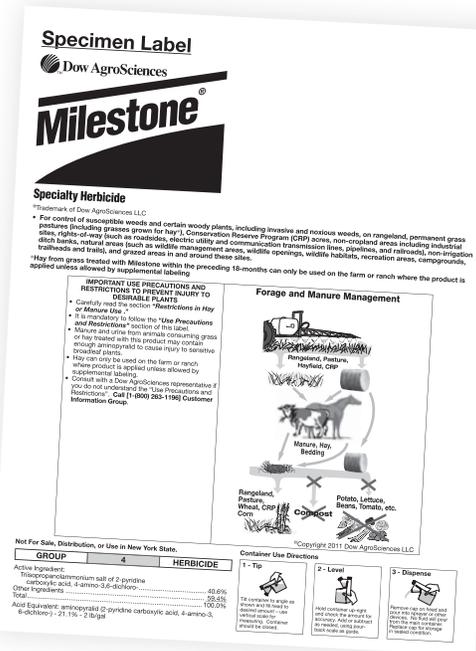
- Strategies to Mitigate Persistent Herbicide Contamination at Your Composting Facility
- Implementing A Plant Growth Testing Program

Herbicides 101

Herbicides are pesticides used by farmers, homeowners, land managers, landscapers, and ranchers to kill “weeds.” Herbicides can be a liquid or a solid but always include one or more active chemical ingredient(s). Herbicides may be **General Use** such that anybody may purchase and use the product, or **Restricted Use** such that only licensed professionals may purchase and use the product. States and regions may restrict some uses of a herbicide that other states allow. Herbicides can be **post-emergence**, meaning they target plants that are actively growing, **pre-emergence**, meaning they target plant seeds before they begin growing, or both. Some manufacturers describe certain post-emergence herbicide products as having “residual control,” which indicates some degree of pre-emergence effect on seeds in the soil.

Individual states require licensure of individuals that apply Restricted Use products or that apply any herbicide products as a business. States require licensed herbicide applicators to attend regular training and to maintain appropriate insurance coverage. Ranchers and farmers are significant users of herbicides and most states regulate such entities less strictly compared to commercial applicators.

Regardless of who purchases and applies a herbicide, **the label is the law.** This means that applicators must not alter, detach, destroy, or use herbicide in a manner inconsistent with or unspecified on the label. Labels are multi-page documents! For instance, the label inset for Milestone® is the



first page of a nine page document.

Technically, the label on the herbicide container is a legal document and users accept the terms of the label once they purchase and use the product. One may find herbicide label copies at <http://www.cdms.net/Label-Database> by selecting the company and then the specific product. For example, selecting “Dow AgroSciences,” and then, “Milestone® Specialty Herbicide,” will link to a web page that includes one or more Adobe Acrobat® (i.e., PDF) label documents that may vary by use, state, or region. Chemical companies are careful to provide requirements and recommendations to users on how to avoid damage to plants and nearby properties or areas not targeted by a herbicide application, such as trees within a lawn treated for broad-leaved weeds. When environmental conditions, such as wind, move a product off-property, it is called **drift**. Labels also provide guidance about how long and what plant species can be planted after a



herbicide application. Misuse of **herbicide** is a violation of federal and state law. Federal and state agencies have revoked licenses, fined, and even jailed, herbicide applicators as punishment for violating the label. Some labels explicitly require notification to downstream users such as facilities that compost treated vegetation. The problem with notification requirements are that most feedstocks for composting pass through many entities before they reach a composting facility. For example, a worst case chain of custody for straw could include a landowner, a herbicide applicator, multiple brokers, multiple haulers, a user of straw bedding, and finally a compost facility.



by half. Michel and Doohan reported half-lives of numerous herbicides during the composting process that ranged from one day to two years (See Table 1).¹

Herbicide concentration reduces by one or more pathways: (1) decomposition by microbes; (2) chemical decomposition; (3) volatilization into a gas; (4) decomposition by sunlight; (5) plant uptake and metabolism; (6) leaching into soil; and (7) surface runoff.² Persistent Herbicides are long-lasting because many decomposition pathways are ineffective or very slow.

Herbicides In Compost

There are thousands of retail herbicide products on the market produced by dozens of companies. Herbicide manufacturers continue to develop new products to counter evolved plant resistance to a particular active ingredient and to target specific groups of plants. The chemical industry continues to research new herbicides that are plant family specific (“Specialty Herbicides”) and that are less toxic to water, soil, wildlife, and humans.

Numerous studies have found that most herbicides rapidly degrade during the composting process. Scientists measure degradation in **half-life** which is the time required to reduce the concentration

Persistent Herbicides

When a facility composts Persistent Herbicide-treated vegetation, it may result in a finished product with concentrations that negatively affect certain, sensitive plants grown in such compost. The irony of Persistent Herbicides are that their environmental benefits of relatively low toxicity and plant family specific action are the source of problems for the composting industry.



Persistent Herbicides are pyridine carboxylic acid chemicals. Dow AgroSciences identifies two families

Table 1. Persistence, decay rate, and safe concentrations of commonly used herbicides that may be found in compost feedstocks and composts.¹

Herbicide	Trade Name	Reported Half Life in Soil (days)	Estimated Composting Half Life (days)	Plant Safe Conc. in Soil (ppb)
2,4-D	Weed-B-Gon, Hi-Dep® Weedar® 64 Weed RHAP A-4D®, Weed RHAP A	7	7-14	500
Atrazine	AAtrex®, Atratol®, Atrazine	100-300	21-50	nd
Clopyralid	Stinger®, Reclaim®, Transline®, Confront, Curtail, Millenium Ultra	15-287	1-2 years ^a	3
Diazinon	Basudin, Dazzel, Gardentox, Kayazol, Knox Out, Nucidol, Spectracide, Diazinon	14-28	1-2	na
Dicamba	Banvel®, Banex®, Trooper®	7-42	nd	50
Glyphosate	Roundup®, Rodeo®, Accord®	3-130	nd	nd
MCPP	Kilprop, Mecopar, Triester-II, Mecomin-D, Triamine-II, Triplet TriPower, Trimec-Encore, U46 KV Fluid	< 60	nd	600
Pendimethalin	Prowl, AC 92553, Accotab, Go-Go-San, Herbadox, Penoxalin, Sipaxol, Stomp and Way-Up.	90	7-14	100
Picloram	Tordon®, Grazon®, Access®, Pathway	20-300	nd	10

Abbreviations: nd=no data, na=not applicable, ^a=limited data.



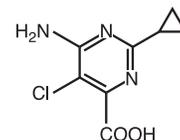
of pyridine chemicals.³ The pyridinyloxyacetic acid herbicide family includes triclopyr and fluroxypyr active ingredients that are very common in hundreds of retail herbicide products and these active ingredients break down relatively quickly. The picolinic acid family includes aminocyclopyrachlor, aminopyralid, clopyralid, and picloram as active ingredients and these are Persistent Herbicides familiar to the composting industry. These active ingredients are included in numerous retail herbicide products.

The active ingredients of Persistent Herbicides mimic natural plant auxins. Auxins are growth hormones that control plant cell growth and elongation. Persistent Herbicides disrupt plant growth by binding to auxin receptor sites which makes the site unavailable for the plant-produced biological auxin. Sensitive plant species include those in Asteraceae (i.e., aster, daisy or sunflower family), Fabaceae (i.e., legume or pea family) and Solanaceae (e.g., tomato and potato) plant families, although some also affect other broadleaf plants and even non-broadleaf plants such as pine, spruce, and fir trees. Established, actively growing grasses are tolerant to Persistent Herbicides. Some highly sensitive plants, such as tomato plants grown in aminopyralid-contaminated compost, may show negative affects at concentrations as low as 1 part per billion. This concentration is the equivalent to ½ teaspoon of product in an Olympic-sized swimming pool.⁴ Some environmental toxicologists have lauded Persistent Herbicides because they are effective at very low concentrations, are most active against a narrow group of plants, and have low toxicity to higher forms of life including humans.⁵ Older alternatives to the newest Persistent Herbicides require higher doses, have higher toxicity, and have more evolved plant resistance that makes them less effective.

In order for a Compost producer to prevent or mitigate Persistent Herbicide contamination, one must understand what they are, who uses them, where they are used including specific uses, how they are used, and why people use them. There are four Persistent Herbicide chemicals known to the composting industry at this time:

Aminocyclopyrachlor

WHAT: Aminocyclopyrachlor is the newest picolinic acid herbicide. DuPont released it under the retail name of Imprelis® in 2010 and Streamline® in 2011. DuPont suspended sale of Imprelis® in 2011 because it caused damage to evergreen trees in, and adjacent to, treatment areas. This was especially problematic because Imprelis® was marketed for landscaped areas such as golf courses where evergreens are common, whereas Streamline® is not labelled for use in landscaped areas. This active ingredient is labelled to provide **pre-emergence** and **post-emergence** control at “extremely low concentrations.” Maximum labelled application rate is 11.5 fluid ounces per acre per year.



WHO: Aminocyclopyrachlor is a **General Use** herbicide used by land managers and landscapers.

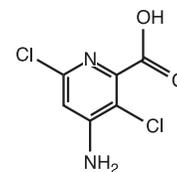
WHERE: Aminocyclopyrachlor is labelled for use at non-crop sites such as industrial turfgrass. It is registered in every state except California and some counties in New York and Colorado. Sensitive plants include a large number of broadleaf species including vines, shrubs, and trees. In general, only established grasses are tolerant. The label specifically states that treated vegetation should not be used for mulch or compost with no caveats that allow composting after some waiting period.

HOW: Aminocyclopyrachlor is applied via ground and aerial spray methods.

WHY: Aminocyclopyrachlor allows land managers to eliminate or weaken plants that would change a site to something other than grasses including broadleaf, noxious, and invasive weeds and woody plant communities.

Aminopyralid

WHAT: Aminopyralid was developed by Dow AgroSciences and first released in 2005. It is a **post-emergence**, selective herbicide. It is not specifically labelled for **pre-emergence** plant control but all labels concede residence time in the soil and call it “residual control” instead. Dow AgroSciences notes that aminopyralid is effective at low rates compared with



Some highly sensitive plants, such as tomato plants grown in aminopyralid-contaminated compost, may show negative affects at concentrations as low as 1 part per billion. This concentration is the equivalent to ½ teaspoon of product in an Olympic-sized swimming pool.

previously-registered broadleaf herbicides including other Persistent Herbicides.⁵ Dow AgroSciences still holds a patent on aminopyralid and sells it in the following retail products: Capstone™, Chaparral™, CleanWave®, Forefront®, GrazonNext®, Milestone®, Opensight®, PasturAll®, and Sendero.™ *Maximum labelled application rate is 7 fluid ounces per acre per year.*

WHO: Aminopyralid is a **General Use** product used by land managers, landscapers, ranchers, and farmers.

WHERE: Aminopyralid is labelled for use in rangeland, permanent grass, pastures (including grasses grown for hay), Conservation Reserve Program (CRP) acres, and non-cropland areas that include industrial sites, rights-of-way (e.g., roadsides, electric utility and communication transmission lines, pipelines, and railroads), non-irrigation ditch banks, natural areas (such as wildlife management areas, [grassy] wildlife openings, wildlife habitats, recreation areas, campgrounds, trailheads and trails), and grazed areas in, and around, these sites. Aminopyralid is not registered for use in New York. Other Northeastern states (Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont) prohibit aminopyralid use on pastures. The only allowed crop use at this time is CleanWave® that is registered in Montana and Florida for control of broadleaf weeds in wheat crops. Dow AgroSciences changed all aminopyralid labels in 2013 in large part due to work by staff at Chittenden Solid Waste District, Williston, Vermont, that found contamination at its composting facility, Green Mountain



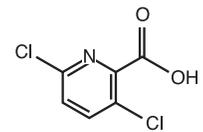
Compost in 2012.^{4,6} The new labels (see Milestone® label inset) make it clearer that treated vegetation and manure from animals that have eaten treated vegetation must not be composted or land applied in an area where sensitive plants will be grown (e.g., soybeans) for at least 18 months. Additionally, treated and harvested plant material cannot leave the farm or ranch where the treatment occurred for 18 months.

HOW: Aminopyralid is applied via ground and aerial spray methods and in cut surface treatments on some woody plants. On a typical application site consisting of actively growing mixed grasses, an applicator would apply Milestone® to the stand at approximate concentrations of 1,700 parts per billion in the treated vegetation.

WHY: Aminopyralid allows land managers to eliminate or weaken broadleaf, noxious, and invasive plants that would change a site into something other than its intended use. Dow AgroSciences markets aminopyralid products as very effective at controlling numerous listed noxious and invasive weeds such as Canada thistle. In addition, manufacturer and independent tests reveal Aminopyralid to be virtually non-toxic to higher forms of life. Metabolically, animals quickly eliminate the active ingredient after ingestion⁷ with little change of the aminopyralid compound or effect on the animal.

Clopyralid

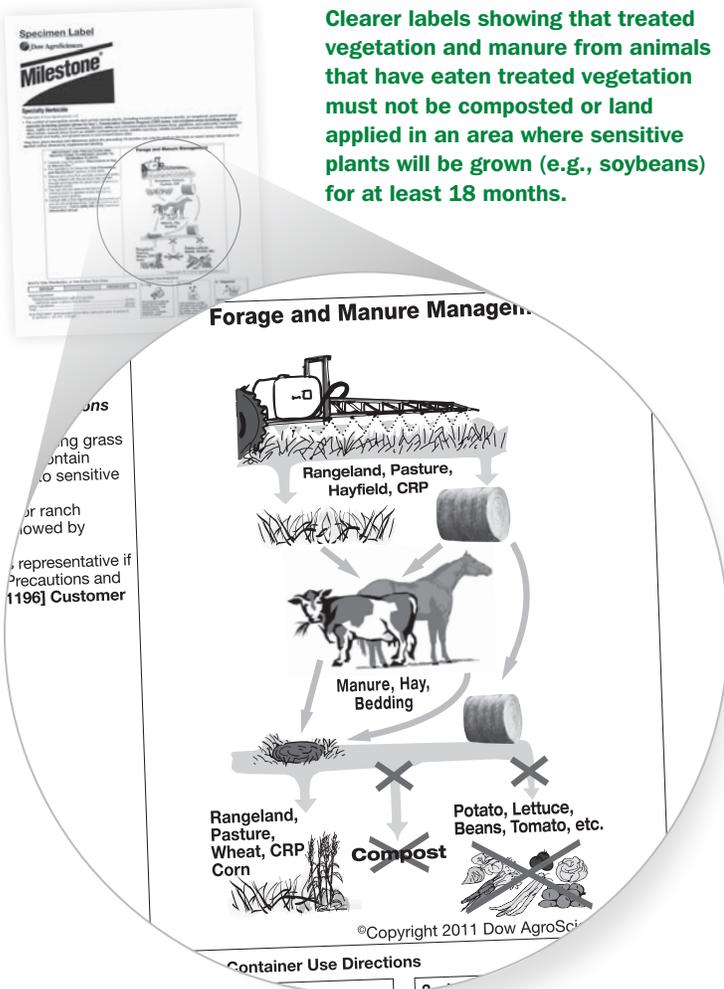
WHAT: Clopyralid was developed by Dow AgroSciences in 1961 and released as a retail product in 1987. It is a **post-emergence, selective herbicide**. Most labels do not indicate **pre-emergence** control but it has known residual effects in soil and many labels include time restrictions on moving soil from treated areas. Dow AgroScience's patent on clopyralid expired, and therefore, many companies incorporate it into numerous retail products. Stinger® is one of the most common retail products and the one with the most licensed supplemental uses. Maximum labelled application rate is 21.3 fluid ounces per acre per year.



WHO: Clopyralid is a **General Use** product used by land managers, landscapers, ranchers, farmers, and homeowners. There are a few uses that are **Restricted Use** such as in cranberry bogs and turfgrass in some states.

WHERE: Clopyralid is widely available in dozens of products, and therefore, it is easiest to list where clopyralid cannot be used. California, New York, Oregon, and Washington do not allow it to be used on turf except for golf courses. Long Island, New York does not allow it to be used at all. Product labels and supplemental labels

Clearer labels showing that treated vegetation and manure from animals that have eaten treated vegetation must not be composted or land applied in an area where sensitive plants will be grown (e.g., soybeans) for at least 18 months.



The first step in this process is to compile a list of retail names of Persistent Herbicide products in your state because very few users will know active ingredient names.

allow it to be used on: blueberries; Brassica leafy vegetables; canola and crambe; corn including silage; cranberry; grasses grown for seed; grass pastures; hayland; hops; natural areas such as CRP and wildlife management areas; nurseries; ornamental plantings, peppermint and spearmint; rangeland; small grains (barley, oats, wheat); sod farms; spinach; stone fruit trees; sugar beets; tree plantings; turfgrass; and turnip.

HOW: Clopyralid is applied via ground and aerial spray methods and in cut surface treatments for some woody plants. It is also included as an ingredient with synthetic fertilizer in some pelletized weed and feed products.

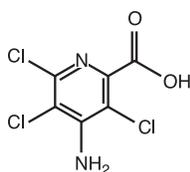
WHY: Clopyralid weakens or eliminates sensitive broadleaf plants so that they do not compete with tolerant plants such as grasses and some crops. It is similar to Aminopyralid in its action and weeds controlled but use rates are nearly triple and practitioners have observed clopyralid resistance in some plant populations. Manufacturer and independent tests reveal clopyralid to be virtually non-toxic to animals and fish. Metabolically, the active ingredient is quickly eliminated following ingestion by animals and organisms with little change of the chemical or effect on the animal.⁸

Picloram

WHAT: Picloram was developed by Dow AgroSciences and first marketed in the U.S. in 1963. Picloram is off-patent with many generic retail products that combine it with other active ingredients for broader weed control. Picloram as a spray is labelled for **post-emergence** control but the active ingredient does persist in the soil for **pre-emergence** control on seeds. Dow AgroSciences retail products intended for spray type applications include: Graslan™, Grazon®, Surmount®, and Tordon® and generic product retail names generally include “22K” or “Picloram.” Maximum labelled rate is 64 fluid ounces per acre per year.

WHO: Picloram became a **Restricted Use** herbicide in 1995 based on hazards to non-target plants when applied via spray type methods. It is still **General Use** when applied to cut shrubs or trees. Farmers, ranchers, and land managers use Picloram.

WHERE: Picloram is registered throughout the U.S. although Hawaii further restricts use beyond the label. Applicators use it to control susceptible broadleaf weeds on rangeland and permanent grass pastures, fallow cropland, Conservation Reserve Program (CRP) acres, non-crop areas including forest planting sites, industrial manufacturing sites, rights-of-way such as electrical power lines, communication lines, pipelines, roadsides, railroads, and wildlife openings in forest and non-crop areas. The label specifies that



users should not use grass or hay from treated vegetation for composting or mulching of susceptible broadleaf plants or crops.

HOW: Picloram is applied via ground and aerial spray methods and in cut surface treatments for some woody plants.

WHY: Picloram was one of the first specialty herbicides that controlled broadleaf plants. Practitioners have observed numerous plants with resistance, and that reality combined with regulatory change to a **Restricted Use** product and availability of more effective products has made Picloram less popular. Similar to studies of other Persistent Herbicides, one Picloram study using dogs revealed that 90% was excreted in urine within 24 hours and no Picloram remained in their system 48 hours after the last dose.⁹

Speaking Your Customer’s Language

Compost producers must be prepared to ask feedstock generators the right questions to understand if those feedstocks may contain Persistent Herbicide contamination. The first step in this process is to compile a list of retail names of Persistent Herbicide products in your state because very few users will know active ingredient names. Two websites allow users to search herbicide products by active ingredient:

- 1. Kelly Solutions** (<http://www.kellysolutions.com/>). This is a company that provides a pesticide database to chemical companies, government agricultural departments and related agencies, general manufacturers and landscapers. Kelly Solutions has enrolled 30 states that share their pesticide registration data. One may search for all registered herbicide products in a state by navigating to the bottom of the main page, selecting the state from the drop-down menu, selecting *Pesticide Registration Search*, then *Search by Active Ingredient*, and then typing the active ingredient name. For example, a search of Clopyralid products in Minnesota returns 44 retail products! A compost producer could copy and paste retail names into a single document for quick and easy reference and then include such a list in a written certification in which a tipping customer reveals any Persistent Herbicide treatments to the a feedstock for composting (see Fact Sheet #2).
- 2. National Pesticide Informational Retrieval System (NPIRS)** (<http://npirspublic.ceris.purdue.edu/state/>). This database is a collection of pesticide-related databases available by subscription. NPIRS has 38 enrolled states. One may search for all registered herbicide products in a state by selecting the state of interest from the map which will link to a page that enables a search by several criteria. Next, the user types an active ingredient name and then

Persistent Herbicides – Fact Sheet #1

Search [state] Pesticide Data button underneath the field. The search will return company names and the user may click to see product names. It is more difficult to obtain a retail product list using this website.

Five states do not subscribe to either of the above services: Arkansas, Louisiana, New Hampshire, South Dakota, and Tennessee. In these states, a Compost producer's best option is to utilize lists from neighboring states and also to speak with your state Department of Agriculture staff.

Conclusion

A Compost producer must have a thorough understanding of what, who, where, how, and why people use Persistent Herbicides. Some Compost producers may find that they can avoid Persistent Herbicide contamination because of their location and their choice of feedstocks. Most composters will compost at least some feedstocks with Persistent Herbicide contamination that could impact their customer's plants and those managers should consult the next fact sheet in the series, *Strategies to Mitigate Persistent Herbicide Contamination at Your Compost Facility*. ▶

For more information, go to <http://compostingcouncil.org/persistent-herbicides>

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