

# Strategies to Mitigate Persistent Herbicide Contamination at Your Composting Facility



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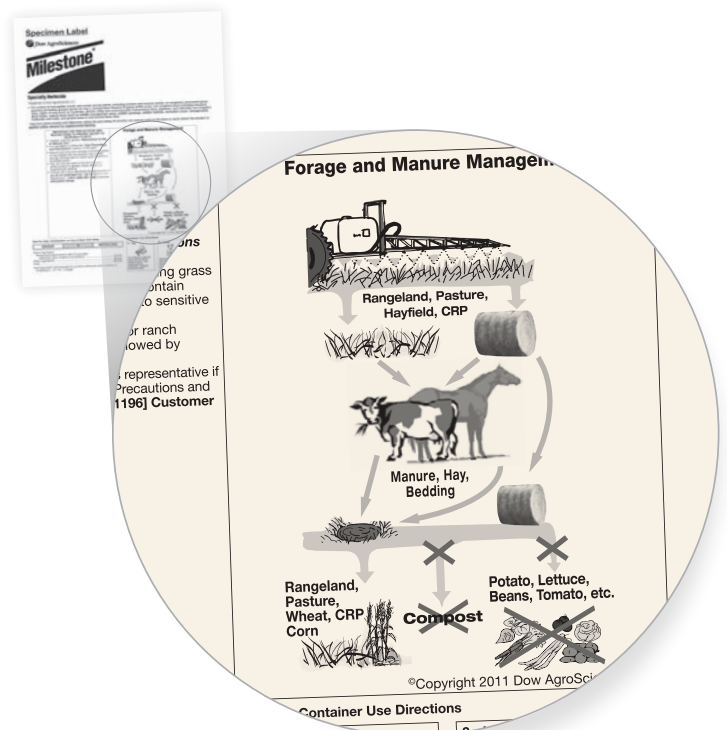
Approximately 15 years ago, compost producers became aware that a certain class of weed killers survived the composting process at concentrations that affected growth of some plants. Our industry has named these weed killers “**Persistent Herbicides**,” and information regarding this problem has appeared in *BioCycle* magazine, on the USCC and several Agricultural Extension websites, at scientific meetings, and in many other sources. One of the latest discoveries occurred at Green Mountain Compost (GMC) in 2012.<sup>1,2,3</sup> GMC has since invested significant staff time and financial resources to change operating procedures and to conduct plant growth testing at a greenhouse on every 100 cubic yards of compost produced at the facility.<sup>3</sup> A recent voluntary survey and plant growth testing analysis of USCC member’s compost by Fred Michel, Ohio State University, revealed that three of 70 composts had concentrations of Persistent Herbicides high enough to stunt plant growth.<sup>4</sup> We do not know how representative the 70 sites are of the composting industry but the observations seem significant. Whitt and Coker observed that five bagged composted manure products in Minnesota contained potentially plant damaging concentrations of clopyralid that ranged from 7 ppb to 80 ppb.<sup>5</sup>

Composting of feedstocks contaminated with Persistent Herbicides may result in finished composts with higher Persistent Herbicide concentrations than the original feedstocks because microbial decomposition reduces mass and volume of the feedstocks but has little effect on the concentration of Persistent Herbicide. Plant damage from composts contaminated with Persistent Herbicides has potential to jeopardize our industry if facilities do not address the issue. These chemicals can negatively affect many important garden vegetables and ornamental plants but many compost users likely fail to recognize symptoms that result from Persistent Herbicide contamination. When compost users do become aware of the cause of plant growth problems, they are quick to react negatively on a scale that rivals other well-known site management issues. For example, GMC received 626 complaints from customers and their staff visited customers’ sites and took thousands of pictures to document alleged Persistent Herbicide plant damage.<sup>1,3,6</sup> It is important that compost producers know what, if any, Persistent Herbicide contamination occurs at their facility so that they are prepared to forthrightly answer their customer’s questions.

Our industry can best address Persistent Herbicides by cooperation among facilities and that effort begins with a strong national organization and continues with a growing number of state organizations. Communication can help all facilities avoid potential problems. For example, one facility may stop accepting a contaminated feedstock that is then accepted by another facility because of a need for material to balance their operation, a desire for additional revenue, or just in the spirit of robust competition. Only by working together will compost producers understand these specific herbicides and potentially-problematic feedstocks and collaboration may ultimately help develop policies necessary to address Persistent Herbicides.

## Problematic Feedstocks

It is difficult to entirely avoid Persistent Herbicide contamination because these products have broad uses and because very low concentrations of a few parts per billion may damage some plants. Some feedstocks have a higher likelihood of contamination than others. A single load of contaminated feedstocks may contaminate all compost produced using that feedstock. Furthermore, there are no quick or affordable tests available to determine if a potential feedstock contains Persistent Herbicides. The first and most important avoidance strategy is to thoroughly understand Persistent Herbicides (see Fact Sheet #1, *Understanding Persistent Herbicides*). Avoid-



ance of contamination may also depend on your location. If your facility occurs on Long Island in New York State where aminopyralid and most clopyralid herbicide use is banned, you may have a different feedstock acceptance standard compared with a facility in the upper Midwest. Laboratory tests can provide accurate concentration data but test results take several weeks and cost several hundred dollars. This is a lot longer than a potential customer is going to wait at your gate for an answer as to whether you will allow tipping of their waste item!



of aminopyralid ranges from 72.2 days on a silt loam soil to 533 days via microbial metabolism.<sup>8</sup> Estimated application rates range from approximately 2,000 parts per billion (ppb) to 5,240 ppb. The most conservative calculation (e.g., 2,000 ppb application, 72.2 days half-life, 18 months) could result in a feedstock at your gate with a concentration of 11.2 ppb. Such a feedstock ingredient could result in a plant-damaging compost depending on its relative amount in the recipe.

If a compost producer finds unacceptable Persistent Herbicide contamination in finished compost, it will be necessary to identify the contaminated feedstock in order to eliminate, reduce, or segregate it. The following list includes some potential sources of Persistent Herbicide contamination obtained from labeled and supplementally-approved uses:

apples, asparagus, barley, beet tops, blueberries, Brassica (Cole) leafy vegetables, canola, Christmas trees, corn (grain or fresh), corn stover, crambe, cranberries, grass (thatch or green clippings), grass hay, hops, oats, peppermint, radishes, rye, soil (from any application site), spearmint, spinach, stone fruits, straw (derived from any small grain crop), strawberries, sugar beets, Swiss chard, tree waste, turnips, and wheat

Problematic feedstocks may arrive at your facility in small quantities that will not overly impact your finished product. A compost producer should scrutinize larger quantity feedstock generators. Unfortunately, even if applicators fanatically adhere to waiting periods required on labels, it is not long enough to avoid potential Persistent Herbicide contamination in compostable feedstocks. For example, one of the longest waiting periods requires that aminopyralid applicators wait 18 months before such material can leave the farm. Measured half-life

The most problematic feedstocks are manures and some agricultural products including food products made from treated crops such as flour, dough, or even pet food. USEPA publishes allowable chemical concentrations in food and animal feeds by chemical name<sup>7</sup> (See Figure 1, USEPA-allowable<sup>7</sup> clopyralid concentrations). Manures can contain concentrated amounts of Persistent Herbicides because these chemicals are mostly unaltered by digestion, and most, if not all, of the Persistent Herbicide passes through the animal in their manure and urine. Digestion efficiency of a horse is approximately 60%, and therefore, 40% of food consumed will be passed as manure<sup>9</sup> but nearly all aminopyralid will be concentrated in the manure and urine. Additionally, the bedding, often small grain straw, may contain clopyralid contamination because it is nearly universally approved throughout North America. Whitt and Coker found clopyralid contamination at 7 ppb in baled corn stover that was used as bedding for dairy cows and 12 to 14 ppb in straw used for bedding horses.<sup>5</sup> Compost produced from problematic feedstocks could carry significant Persistent Herbicide contamination (see Figure 2, PH Concentration Math).

**Maximum Persistent Herbicide Concentrations In Finished Compost**

Needless to say, zero contamination should be the goal of any compost producer, however, this is not realistic for all composting facilities and may undermine environmental benefits of efforts to divert

**Figure 1: USEPA-allowable<sup>7</sup> clopyralid concentrations**

• brassica, head and stem .....	2,000 ppb	• grass hay .....	500,000 ppb
• barley, oat, wheat grain .....	3,000 ppb	• milk .....	200 ppb
• blueberry and other bushberry .....	12,000 ppb	• Swiss chard .....	3,000 ppb
• cattle meat .....	1,000 ppb	• turnip .....	4,000 ppb
• cattle meat by-products .....	36,000 ppb	• wheat straw .....	9,000 ppb

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organic material away from landfills if compost producers rejected all problematic feedstocks. The following maximum concentrations should only be used as guidelines and a compost producer's goal should always be to keep contamination as low as possible:

- Aminocyclopyrachlor, 10 ppb<sup>10</sup>
- Clopyralid, 10 ppb<sup>10</sup>
- Aminopyralid, 3 ppb<sup>10</sup>
- Picloram, 10 ppb<sup>10</sup>

Additionally, Persistent Herbicide concentration in a finished compost and plant response to that compost will vary by plant species, location, soil chemistry, weather, and even time of year. A measured concentration of Persistent Herbicide in a dry, cold part of the U.S. may persist longer than the same concentration in a wet, warmer part of the U.S. because these active ingredients are relatively water soluble.

### Figure 2: PH Concentration Math

#### Manure

Over a 5 day period, a horse owner feeds her horses 50 kg (110 lbs) of hay harvested from a pasture treated with aminopyralid to control thistle. The hay has a concentration of 12 ppb aminopyralid. At 40% digestion efficiency, 20 kg (44lbs) manure results with concentrated aminopyralid:

$$\text{Calculation: } (50 \text{ kg hay})(12 \text{ ppb aminopyralid}) = (20 \text{ kg manure}) (X \text{ ppb aminopyralid})$$
$$x = 30 \text{ ppb aminopyralid in the manure}$$

#### Bedding

Over a 5 day period, she beds her horses using wheat straw with a total weight of 120 kg (265 lbs). The farmer that grew the wheat used clopyralid to control broad leaf weeds in his crop. The wheat straw has a clopyralid concentration of 12 ppb.

#### Composting

She is an avid gardener and she composts her own manure in small batches using the static pile method and uses the compost on her property. This week, her batch of 140 kg (309 lbs) consists of 20 kg manure and 120 kg straw bedding. The manure and bedding has a carbon to nitrogen ratio of 33:1 which is an acceptable ratio for composting. Both persistent herbicide concentrations are reduced somewhat by dilution with the other feedstock:

*Aminopyralid is diluted by the wheat straw:*

$$(20 \text{ kg manure})(30 \text{ ppb aminopyralid}) = (140 \text{ kg in recipe}) (X \text{ ppb aminopyralid})$$

$$X = 4.3 \text{ ppb aminopyralid in the recipe}$$

*Clopyralid is diluted by the manure:*

$$(120 \text{ kg straw})(12 \text{ ppb clopyralid}) = (140 \text{ kg in recipe}) (X \text{ ppb clopyralid})$$

$$X = 10.3 \text{ ppb clopyralid in the recipe}$$

She composts the mixture for 150 days and this transforms 140 kg of feedstock into 70 kg (154 lbs) of compost for her gardens. This causes both persistent herbicides to concentrate due to loss of mass in the feedstocks:

$$\text{Aminopyralid: } (140 \text{ kg recipe})(4.3 \text{ ppb aminopyralid}) = (70 \text{ kg compost}) (X \text{ ppb aminopyralid})$$

$$X = 8.6 \text{ ppb aminopyralid}$$

$$\text{Clopyralid: } (140 \text{ kg recipe})(10.3 \text{ ppb clopyralid}) = (70 \text{ kg compost}) (X \text{ ppb clopyralid})$$

$$X = 20.6 \text{ ppb clopyralid}$$

#### PH Degradation

Persistent Herbicides do degrade slowly during composting. If aminopyralid and clopyralid have half-lives of 533 days, how much will be left after the compost is ready for her garden? One can search online for a "half-life calculator" and use the following variables:

$$\text{Aminopyralid: } \text{Time} = 150 \text{ days, Half-life} = 533 \text{ days, and Concentration} = 8.6 \text{ ppb}$$

$$\text{Clopyralid: } \text{Same as above except initial concentration equals } 20.6 \text{ ppb.}$$

The finished compost will have an aminopyralid concentration of approximately 7 ppb and a clopyralid concentration of 17 ppb.

### Testing For Persistent Herbicides

**Chemical Testing.** Testing for Persistent Herbicides in a compost or a feedstock is difficult because both are heterogeneous mixtures. Laboratory analysis requires extracting the active chemical ingredient followed by accurate and precise measurement of these chemicals at extremely low concentrations.<sup>3</sup> A benefit of chemical testing is that the data is quantitative in parts per billion and accurate to within parenthetical concentrations listed below for the following laboratories:

- Anatek Labs, Inc., 1282 Alturas Drive, Moscow, ID 83843, 208-883-2839, <http://www.anateklabs.com/>. Anatek labs tests for aminopyralid (1–5 ppb) at a cost of \$200 per sample and for both clopyralid (1–5 ppb) and picloram (1–5 ppb) at a cost of \$200 per sample.
- EPL Bio Analytical Services, 9095 West Harristown Blvd., Niantic, IL 62551-9752, 866-963-2143, <http://eplbas.com/>. EPL tests for aminopyralid (1 ppb), clopyralid (1 ppb), and picloram (1 ppb) at a cost of \$500 per sample.
- Golden Pacific Laboratories, 4720 West Jennifer Avenue, Fresno, CA 93722 (559) 275-9091, <http://www.gplabs.com/> tests for aminocyclopyrachlor (1 ppb), aminopyralid (10 ppb), clopyralid (10 ppb), and picloram (10 ppb). Costs include \$1500 methods set up, \$50 per sample homogenization fee, and \$225 per sample for active ingredient testing.
- Montana State University, McCall Hall, Bozeman, MT 59717, 406-994-3383 <http://www.analyticalab.mt.gov>, tests for aminocyclopyrachlor (0.15 ppb), aminopyralid (0.5 ppb), clopyralid (5 ppb), and picloram (0.5 ppb). Cost is \$250 per sample per active ingredient. MSU is a public institution and Montana customers come first. One must call before sending samples.

A compost producer should consider chemical testing after finding Persistent Herbicide contamination in compost using plant growth testing. Then, a compost producer can employ chemical testing to confirm plant growth testing results and to test feedstocks as far up-stream as possible because this will identify the sources of the problem. For example, Whitt and Coker traced clopyralid contamination to baled corn stover used for bedding dairy cows when plant growth testing revealed Persistent Herbicide contamination in a composted manure.<sup>5</sup>

**Plant Growth (i.e., Bioassay) Testing.** Several labs conduct germination and seedling vigor testing:

- Ag Analytical Services Lab, Penn State University, Tower Road, University Park, PA 16802, 814-863-0841, <http://agsci.psu.edu/aasl/compost-testing>. Cost is \$75 per sample

- A & L Canada Laboratories, Inc., 2136 JetStream Rd., London, ON N5V 3P5, (519) 457-2575, <http://www.alcanada.com/BioMicro-Cides.htm>. Call for costs
- Control Lab, Inc., 42 Hangar Way, Watsonville, CA 95076, (831) 724-5422, <http://www.biocharlab.com>. Cost ranges from \$75 to \$125 per sample
- The Ohio State University, 1680 Madison Ave., Wooster, OH 44691. Call for costs. Contact Fred Michel, 330-263-3859, [michel.36@osu.edu](mailto:michel.36@osu.edu)
- Soil Test Farm Consultants, Inc., 2925 Driggs Dr., Moses Lake, WA 98837, 509-765-1622, <http://www.soiltestlab.com/compost-tests.html>. Cost is \$125 per sample
- Woods End Laboratories, Inc., 290 Belgrade Road, P.O. Box 297, Mt Vernon, ME 04352 <https://woodsend.org/compost/herbicide-bioassay/>, (800) 451-0337. Call for costs

In general, plant growth tests only evaluate finished compost and results are qualitative (e.g., “none,” “slight,” “moderate,” “severe” damage). Some labs have taken analysis a step further by conducting plant growth tests using known concentrations of one or more Persistent Herbicides and then evaluating plant response on a relative scale (Example: Woods End® Laboratories, *Plant Injury Risk Management*, <https://woodsend.org/compost/herbicide-bioassay/>). Importantly, most lab staff have conducted thousands of plant growth tests and have a keen eye for symptoms of Persistent Herbicides. Plant growth tests require a media capable of growing a plant and this may not be possible with most feedstocks, but lab staff have clever ways around this problem and a compost producer should consult with lab staff for particular feedstocks.<sup>11</sup>

It is also a good idea for your compost facility to implement regular plant growth testing (see Fact Sheet #3, *Implementing a Plant Growth Testing Program*). In any case, a combination of chemical tests and plant growth tests may enable a compost producer to narrow down the source and extent of Persistent Herbicide contamination.

### Best Management Practices To Minimize Contamination

Your operations plan should include all best management practices that you intend to practice at your facility to mitigate Persistent Herbicide contamination. These practices may help ameliorate liability in the event that a compost customer does allege plant damage, however, like all components of an Operations Plan, one

**These practices may help ameliorate liability in the event that a compost customer does allege plant damage, however, like all components of an Operations Plan, one must follow the plan!**

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must follow the plan! Best management practices could include the following:

1. Regular plant growth tests of your compost products. See Fact Sheet #3, *Implementing a Plant Growth Testing Program*, for a simple, in-house, plant growth test method that you can implement in combination with laboratory testing.
2. Unless your facility conducts regular testing, consider refusing to accept problematic feedstocks if the amount of the feedstock would be a significant quantity relative to your operation. For example, it may not be significant if a hauler of urban green waste brings a thousand tons of green grass, a potentially problematic feedstock, to your 60,000 tons per year composting facility because it is only because it is only 1.6% of your recipe. The estimated risk of any given feedstock will depend on testing and a compost producer's best professional judgment.
3. A written certification from a feedstock generator that intends to tip a significant quantity of a problematic feedstock. It is beyond the scope of this fact sheet to provide such a certification because it will differ depending on many factors and legal advice. Let the entity know that the reason that you require this certification is because some weed killers do not break down during the composting process and may result in a compost product that harms some plants. You could inform the generator that you test for these chemicals if that is true. The certification document may include:
  - Description of the feedstock
  - Name of the authorized representative of the source of the feedstock. This may not be the hauler of the feedstock. For example, a compost producer should utilize the name of the horse race track manager or owner instead of the company that hauled the material to your facility
  - Date
  - Volume or weight of the feedstock
  - Identification of any upstream producers of the feedstock. For example, the source of straw for bedding from a horse stable
  - Yes or no answers whether the generator is aware of any applications of Persistent Herbicides to the feedstock using a list of approved products available in the state of origin
  - Signature and legible printed name of an authorized representative of the entity

4. Compost problematic feedstocks separately and conduct chemical analysis and regular plant growth tests on finished compost from those feedstocks
5. Obtain chemical analysis of a suspicious feedstock and then utilize recipe algebra to determine how much dilution with other feedstocks will be necessary to mitigate potential contamination to levels that are less likely to harm your customer's plants.<sup>3</sup> This is similar to spreadsheet methods used to achieve optimal carbon, nitrogen, and moisture content for a composting recipe. The goal in recipe algebra should be to reduce Persistent Herbicide concentration below the maximum rates reported above, but remember that concentrations will increase in finished compost.
6. Adopt a set of compost product use guidelines such as those required of USCC Seal of Testing Assurance program participants. Publish these guidelines on all marketing materials including your website and provide these guidelines to every customer that purchases compost. Compost product use guidelines generally recommend soil organic contents of 20% or less by volume that can be achieved by: (1) purchasing soil blends of varying mixtures of compost and other ingredients such as mineral soil and sand; or, (2) mixing compost with on-site soils. These are good practices because they will also dilute any potential contamination by five times or more.
7. If you do find evidence of Persistent Herbicide contamination in your compost products, report your observations to your state Department of Agriculture or another agency that is responsible for regulating pesticide use. Additionally, utilize the online reporting form on the USCC website (<http://compostingcouncil.org/persistent-herbicide-incident-report>). Provide as much data as possible including source of the problematic feedstock(s), your signed certification(s), any chemical tests for active ingredients, and plant growth test data. This is how northeastern states obtained a prohibition to use of aminopyralid on pastures. Other states have banned use of clopyralid in residential turf grass. Your state agency may even agree to pay for some chemical testing of your product.
8. Another proven method to reduce concentration of Persistent Herbicides is to add activated carbon to your compost. As little as 1% on a dry weight basis can eliminate up to 100 ppb Persistent Herbicide contamination.<sup>4,10</sup> Green Mountain Compost uses 5% high-carbon wood ash by volume.<sup>6</sup> Good quality wood fly ash may be hard to find. Sources to check would be users of wood fired burners and boilers in your area. The ash should be



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closer to black in color compared to gray because gray indicates that most of the carbon has been oxidized by combustion.

High-carbon wood ash can eliminate up to 30 ppb Persistent Herbicide contamination.<sup>4,10</sup>

9. Ask your customers how they intend to use your compost product and offer them a suitable soil blend for that application. A compost producer should be especially wary if a potential customer intends to use compost to grow plants that are sensitive to Persistent Herbicides such as tomatoes.
10. If you do find Persistent Herbicide contamination at concentrations that cannot be mitigated by one of the above Best Management Practices, specify that compost for turf applications only. Grasses are mostly tolerant to Persistent Herbicides especially when the turf has adequate water and nutrients.

### Conclusion

Managing Persistent Herbicide contamination requires that a compost producer be at least as knowledgeable as individuals that use these chemicals. It is important that a compost producer first understand Persistent Herbicides (see the Fact Sheet in this series, *Understanding Persistent Herbicides*), and then utilize practices to avoid and mitigate contamination. Detection of contamination requires routine, repeated plant growth tests and chemical tests that may stretch already thin financial and time resources. Laboratory tests are important but one way to lessen expenses is to conduct regular plant growth tests in-house and this is the topic of the third fact sheet in this series, *Implementing a Plant Growth Testing Program*. ▶

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

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