Land Quality Division

Clopyralid Study

February 2003

DEQ
State of Oregon
Department of Environmental Quality

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This report and additional information is also available on the DEQ Web site at: http://www.deq.state.or.us/wmc/solwaste/composting.html. You'll find DEQ fact sheets on clopyralid, compost, and how to apply compost. Also, there is information about Washington State University's study on clopyralid and garden demonstration plots, and Dow AgroSciences' sensitive plant list.

DEQ Clopyralid Study

The Oregon Department of Environmental Quality (DEQ) recently completed a study to determine if compost from DEQ-permitted composting facilities contains clopyralid residue. The two-phased study, conducted June through October 2002, was designed to collect samples of "for sale" compost from a representative number of DEQ-permitted commercial compost facilities located throughout the state. Samples were analyzed for clopyralid by analytical and by bioassay seed germination laboratories.

Summary of Study Findings & Methodology

- Clopyralid residue is present in compost processed at DEQ-permitted facilities at levels that have shown to effect sensitive plant species.
- The study sampled 12 of the 36 DEQ-permitted facilities. Samples were taken in June and October to include any seasonal feed stock variations.
- There was an effort made to collect samples from manure-based feedstocks. However, there was not enough finished compost available. Therefore, these results are based on compost produced mainly of yard debris from landscape maintenance, residential curbside collection and residential self-haul.
- Phase I results (12 samples collected in June 2002) --- Analytical test (EPA 8151A method): Four samples showed clopyralid residues at levels between 7.6 and 38 parts per billion (ppb) dry weight. Six samples results were inconclusive. Two samples showed no detection. Bioassay test: Two samples rated as "pass" (no visual impact). Remaining 10 samples showed some visual plant foliage impacts. (Note: While research continues, studies have shown that clopyralid as low as 10 parts per billion (ppb) can affect some sensitive plants.)
- Phase II results (12 samples collected in October 2002) --- Two analytical tests were conducted: (1) EPA 8151A Method: Nine samples showed clopyralid ranging from 8.3 to 49 ppb; (2) GC/MS (Gas Chromatograph/Mass Spectrometry) Method: Clopyralid residue present in all samples, ranging from 6.3 to 94 ppb. Bioassay test: One sample rated as "pass" (no visual impact). Eleven samples showed visual plant foliage impact.
- The study's Technical Committee concludes that the GC/MS Method provides the clearest indication of clopyralid levels.
- Results from the Phase II GC/MS method should not be used to conclude that clopyralid detection in Oregon is higher than in other states. The GC/MS method, used by the laboratory in Phase II, was specifically designed in collaboration with Dow AgroSciences to detect clopyralid at low very levels. In comparison a recent King County, Wash., study used three different analytical methods. In that study the GC/MS method also showed greater sensitivity.
- The increased prevalence of clopyralid in Phase II of the study is likely due to seasonal variations in feedstock (i.e. feedstock from the spring with higher levels of clopyralid-treated grass clipping).
- There was no specific correlation between the level of clopyralid residual levels and the type of composting process used or the length of the composting process.
- While clopyralid residue has not received the same widespread attention and press coverage in Oregon as in Washington and California, DEQ did receive a number of reports and concerns about suspected plant damage from gardeners and the public. The Technical Committee recommended that samples be collected and tested from two adjoining properties located in the metropolitan region. Samples were collection for analysis by both analytical and bioassay laboratories. The tests were funded by the Metro Regional Government's composting program. Results from the test showed clopyralid residue at levels significant enough to affect sensitive plants.

Background

Clopyralid is a broadleaf herbicide manufactured by Dow AgroSciences and used in lawn, turf and agriculture products for suppression of weeds such as clover, thistle and dandelion. Generally, clopyralid-treated material appears to be entering the composting process from lawns treated by professional lawn care providers and homeowners. Agricultural feedstocks containing clopyralid treated materials used in the production of agricultural commodities may also enter the composting process through manure or animal bedding. However, few samples taken for the DEQ study contained either manure or animal bedding.

Of the estimated 10,000 pesticide products registered annually by Oregon Department of Agriculture for sale, distribution and use in Oregon, only 21 products containing clopyralid were registered in 2002. Clopyralid residues may be in finished compost product at parts-per-billion (ppb) levels. Even small amounts of clopyralid can affect sensitive plants in the legume and nightshade (solanacea) families including tomatoes, peppers, potatoes, peas, beans, clover, alfalfa and sunflowers.

Clopyralid concerns first surfaced in eastern Washington when growers in Spokane and Pullman experienced crop damage that was later traced to clopyralid. It was believed that in the Spokane case, the source of the clopyralid residue was a product called "Confront." At Washington State University clopyralid was discovered in the materials composted and in the finished compost. Similar problems have been reported in other states.

Oregon's Compost Industry

Currently, there are 36 DEQ-permitted composting facilities in Oregon. DEQ regulates commercial compost facilities as solid waste disposal sites as set out in Oregon Administrative Rules Chapter 340, Division 93, 96 and 97. A compost facility is defined as a site or facility that utilizes organic solid waste or mixed solid waste to produce a useful product through a managed process of controlled biological decomposition.

The goal of the state's regulations, adopted by the Oregon Environmental Quality Commission in 1997, is to protect human health and environment while continuing to promote composting. Compost permit requirements vary depending on the type and amount of feedstock (compostable material) that facilities process. Requirements include mass balance calculations, water quality protections and the design of physical features of the site. Larger facilities must comply with more human health and environmental protections because of their greater risk, are inspected on a regular basis, and can be fined for permit violations.

Composting yard debris and other organic waste not only reduces the amount of materials going to landfills and saves money. The average cost of disposing a ton of material in Oregon's landfills is $55 a ton, which means it would have cost more than $19 million to dispose of yard debris that was composted in 2001.

Composting has proven to be an economically significant and important industry within Oregon in just a few years. Generally, processors of recyclable materials such as paper, tin and glass pay for the materials; however, compost facilities are able to charge an average tip fee of $20 a ton on incoming feedstock. Bulk compost is sold at an average price of $28 a ton. Most compost in Oregon is sold in bulk; however, several facilities bag the product for retail sales. Retail price is generally $2 for a cubic foot bag, which would mean a value of about $100 a ton.

Oregon's Recovery Goals

State law ORS459A.010 sets statewide goals for Oregon's recovery of recycled materials.

- For calendar year 2005, the amount of recovery from the general solid waste stream shall be at least 45 percent;
- For calendar year 2009, the amount of recovery from the general solid waste stream shall be at least 50 percent;
- See state law at: http://landru.leg.state.or.us/ors/459a.html

ORS 459A also set waste recovery goals for each county to reach by 2005 and 2009. These rates range as high as 62% by 2005 and 64% by 2009 in the Metro area.

Oregon has been making continual progress in achieving these goals, with programs being implemented throughout the state. The state has climbed from a 27% recovery rate in 1992 to a 46% rate in 2001, which means Oregon is on course to achieve the 50% goal set by the Legislature for 2009.

Yard debris composting has helped Oregon achieve a substantial portion of the goal. In 2001, the Oregon Material Recovery Survey showed that in 2001 a total of 348,472 tons of yard debris were collected and composted/utilized; this is almost 18% of all the recyclable material collected in the state. Nearly 40 Oregon jurisdictions now sponsor curbside yard debris collection programs.

Yard debris has one of the highest recovery levels for any single material and far exceeds the amounts of some other common materials recovered such as newspaper, glass containers, plastics and office paper. If yard debris had to be disposed of in landfills rather than recycled, Oregon's 2001 recovery rate would have dropped to 39% - a seven percent reduction and far below the goal set by the Legislature for 2005 or 2009. DEQ believes that the recovery goal is not achievable unless we can continue to develop and implement good composting programs.

Please note: This analysis does not take into account home composting of grass clippings and other yard debris. Besides trying to promote recovery, many local governments are actively promoting the home composting of grass and yard debris. ORS 459A contains incentives and requirements to encourage the adoption of these home composting programs. If grass cannot be home composted due to clopyralid residue, it will need to be disposed of, adding to the disposal rate and further reducing the recovery rate.

Compost has a number of environmental benefits which include improving soil health by adding organic matter and nutrients to the soil. Reducing the need for pesticide and fertilizers is vital to the integrity of organic farming and gardening. In addition, compost use has greatly expanded to reduce erosion and storm water runoff at construction sites and on road projects.

Task Force

In January 2002, DEQ organized a task force to review the concern of potential clopyralid residue in compost and determine if further study should be made. Reports from Washington and California gave rise to specific concern about potential impact on Oregon's composting program. Composters as well as the general public were concerned about the marketability of the product. Any lack of public confidence in the finished product could severely damage the compost industry. Compost operators felt that they did not have ability to identify or control clopyralid-tainted materials brought to their facilities, and implementing any on-going testing could prove expensive.

The task force concluded that a sample study would determine if there was a statewide problem while maintaining the confidentiality of the compost operators who volunteered to participate. Members of task force included representatives of the Oregon Department of Agriculture, which regulates the sale, use and distribution of pesticide products in Oregon; the Composting Council of Oregon; Metro, which licenses compost facilities in the region; and DEQ solid waste and laboratory staff. DEQ oversees the composting process in Oregon by issuing permits to commercial compost facilities. The study's Technical Committee, which included inorganic and organic chemists from DEQ, as well as an Oregon State University weed and chemistry specialist, was formed to review the laboratory analytical results. (See list of Task Force member at the end of the report).

Study Design

The study included analytical analysis and bioassay seed germination tests. The analytical laboratory enlisted for conducting Phase I used EPA method 8151A. This method generally is used to test for a variety of herbicides residue at levels much higher than the parts per billion that were found in compost in Washington state. Phase I results indicated that this method has limitations in detecting clopyralid, particularly at parts per billion (ppb) levels. To ensure that the study produced clear results, the committee decided to contract with a second laboratory that used a GC/MS method for Phase II of the study. The laboratory using this method had worked with Dow AgroSciences, the maker of clopyralid, to develop the method. In the judgment of the Technical Committee, the GC/MS method is a more reliable method for detection of clopyralid residue at the parts per billion level in compost.

- The study sought the volunteer participation of 12 DEQ-permitted compost facilities. This represented 33% of the 36 permitted facilities in Oregon.
- Criteria for study participation included: facilities most likely to accept yard debris from lawn care providers; facilities that accepted manure; and statewide geographic representation. Eight of the participants reported that the compost samples were made from 80-100% yard debris; wood waste made up most of the remaining feedstock. While the study's goal was to test compost that included manure, there were not enough facilities with manure as feedstock participating to draw any conclusions.
- Names and locations of the study's participants are confidential. Individual participants were notified of the sample results from their facility.
- Participating facilities all used a managed compost process. Five used the windrow method; one windrow with blowers; five the giant pile method; and one, the static method without blowers. The compost was processed between three and fourteen months.
- Only "for sale" compost was tested. This refers to compost that has completed the composting process and is available to the market.
- The study was divided into two phases to insure that seasonal variations in feedstock would be represented. Samples for Phase I of the study were collected in June. The compost process generally requires anywhere from four to nine months to complete. The task force made the assumption that samples collected for Phase I would contain composting materials higher in woody debris. Phase II samples were taken at the same facilities in October with the assumption that higher levels of grass clippings would have been collected in the Spring and Summer, and those clippings may have been more recently treated with clopyralid.
- Invitations to Bid were released to solicit bids for a Technical Project Coordinator to collect samples and act as a representative to the participating composting in order to maintain confidentiality. Bids were also solicited for an analytical and a bioassay laboratory.
- A Technical Advisory Committee was formed to review the laboratory processes and quality control and to make conclusions about the findings. Advisors included DEQ inorganic and organic laboratory specialists, an OSU chemist and a weed specialist.

Study Results

In Phase I, clopyralid residue was found in four (33%) of the facilities. Four samples showed clopyralid residue between 7.6 ppb and 38 ppb (dry weight) which was confirmed by the bioassay. Six samples showed abnormal plant growth in the bioassay but could not be confirmed in the analytical tests, and two samples showed no analytical or bioassay detections.

Phase I laboratory results were obtained by using a modification of an EPA-approved method (EPA Method 8151A) that is commonly used for quantifying herbicide concentrations. Because six samples could not be confirmed in the first phase of the study, the study's Technical Committee recommended that for comparison a second laboratory and method be added for Phase II. The second laboratory used a "GC/MS" method, which it developed in collaboration with Dow AgroSciences specifically for detecting clopyralid at the parts per billion level.

In Phase II only one sample showed no visual effects in the bioassay test. The EPA method detected clopyralid in nine of the 12 samples, with a range 8.3 to 49 ppb dry weight. The laboratory using the GC/MS method detected clopyralid in all samples, ranging from 6.3 to 94 ppb (see table). The study's Technical Committee concluded that the GC/MS method, which uses different extraction steps and solvents, provides the clearest indication of clopyralid residue. The GC/MS method resulted in the following clopyralid levels measured in dry weight for the 12 facilities tested:

- 5 facility samples between 6 ppb and 25 ppb
- 4 facility samples between 25ppb and 50ppb
- 3 facility samples between 50ppb and 94ppb

Two things may attribute for the higher clopyralid levels found in Phase II results. First, the compost collected in October 2002, for Phase II may have included greater amounts of grass clippings that could have been treated with clopyralid in the spring months. Secondly, the GC/MS method used in Phase II and which was specifically designed in collaboration with Dow AgroSciences to test for clopyralid at the parts per billion level, is a more sensitive method and would likely be more apt to detect clopyralid residue.

Laboratory Results Phase I and Phase II

Phase I Samples taken in June, 2002		Phase II Samples taken in October, 2002		
EPA Analytical Method 8151 A dry weight parts per billion (ppb)	Bioassay Visual Score [See Scale Below]	EPA Analytical Method 8151 A dry weight parts per billion (ppb)	GC/MS Method dry weight parts per billion (ppb)	Bioassay Visual Score (Red clover was not scored due to inadequate growth) [See Scale Below]
38 ppb	Bean 3 Pea 2 Red clover 1	49	94.2	Bean 1 Pea 2
*	Bean <1 Pea 1 Red clover 1	28	58.4	Bean 1 Pea 2
7.6 ppb	Bean 1 Pea 1 Red clover 1	32	56.2	Bean 1 Pea 2
23 ppb	Bean 3 Pea 1 Red clover 1	28	39.3	Bean 1 Pea 2
*	Bean <1 Pea <1 Red clover <1	9.9	36.8	Bean < 1 Pea 2
12 ppb	Bean <1 Pea 1 Red clover 1	33	29.3	Bean <1 Pea 2
*	Bean 3 Pea 2 Red clover 1	9.1	25.4	Bean 0 Pea 1
No Detection	Bean 0 Pea 0 Red clover 0	12	21.3	Bean 0 Pea <1
No Detection	Bean 0 Pea 0 Red clover 0	8.3	17.2	Bean <1 Pea 1
*	Bean 1 Pea <1 Red clover 0	**	16.7	Bean 0 Pea 1
*	Bean <1 Pea 1 Red clover 1	**	11.4	Bean 0 Pea 1
*	Bean 0 Pea <1 Red clover <1	**	6.3	Bean 0 Pea 0

The (*) (**) are samples in which clopyralid was observed but the test was unable to provide confirmation. Analytical Laboratory Notation: Qualified identification because no second column confirmation. There was a retention time shift on second column.

The Scale for the visual assessment of herbicide symptoms:
0 = healthy
1 = slight leaf curling/ cupping
2 = moderate leaf curling, apical meristem abnormal, swollen stems present
3 = severe leaf curling or twisting of stem or petioles
4 = death

* Phase I results marked with * ranged from a high of 21 ppb to a low of 6.1 ppb.
** Phase II results marked with ** ranged from a high of 19 ppb and a low of 7.6 ppb.
Bioassay tests: All bioassays were scored 21 days after seeds were planted. Phase I was conducted in June when the day length was very long, approximately 16 hours. Phase II was conducted in late October when day length was very short, so artificial light was provided for 12 hours per day. For both phases temperature control in the greenhouse was set for 65 F day / 55 F night. Pea growth in Phase I and II was similar, but there was less growth in bean and red clover by 21 day in Phase II. For the purpose of this study any sample with a visual score greater than zero for either bean or pea was rated as “fails”.

Conclusions and Recommendations

This study confirms that compost at DEQ-permitted facilities in Oregon contain significant levels of the herbicide clopyralid. The level of residue varied depending on the seasonality of the feedstock materials. Lawn clippings collected with yard debris appears to be the major contributing source of the residue; however, the samples collected for this study did not include enough manure or animal bedding sources to make any conclusions about the potential impacts of agricultural sources.

The Clopyralid Task Force and Technical committees made the following recommendations:

1. Quick action needs be taken to limit or eliminate the primary sources of clopyralid residue in the compost system before herbicide applications are made in Spring, 2003.
2. Specific urban and residential uses of clopyralid should be restricted. These measures are necessary to protect and insure continued success of composting in Oregon and to preserve consumer confidence in compost products.
3. It is likely that as lawn care services, yard debris collection and composting continue to expand in Oregon, the potential for clopyralid residue will increase in the future.
4. DEQ and ODA should review regulatory and policy remedies.
5. The compost industry should work to inform feedstock providers and customers about clopyralid residue.
6. The study results should be provided to the U.S. Environmental Protection Agency, Dow Agro Sciences and Oregon clopyralid registrants.
7. Studies to detect clopyralid are hampered because there is no Standard Reference Materials guidance available. Clear analytical objectives need to be established for analytical laboratory testing.
8. The Clopyralid Task Force should develop an Action Plan to continue to monitor the progress in limiting or eliminating clopyralid residue in compost.
9. Follow up monitoring of the compost system should be done to determine if clopyralid residue is continuing to enter the system. The monitoring should include both lawn care and agricultural sources.

Reported Plant Damage

In August 2002 testimony was given to the DEQ Solid Waste Advisory Committee (SWAC) by adjoining property owners who had purchased compost from a Metro licensed facility. Both parties reported that a number of sensitive plants on their properties had either died or failed to thrive. The advisory committee decided to test the compost from a pile that remained on site. The compost had been purchased in early summer 2003. The compost was purchased from a facility located in the Metro Region and holds a Metro composting license. The facility participated in Metro's voluntary Earth-Wise Compost Designation Program and received a certification for 2002/2003. The program standards include: pH; heavy (trace) metals including cadmium and lead; pesticide residue including pentachorophenol and chlordane; plant nutrients including boron, calcium, magnesium, copper and zinc; salts; seeds; and foreign matter**.**

Metro collected the sample in October 2002 and funded the test by the analytical laboratories and the bioassay laboratory. (See Letter to DEQ SWAC Reporting Plant Damage, Appendix 5).

Test Results: EPA 8151A wet weight 24, dry weight 52; percent solids 46.3 – 50.2. GC/MS wet weight 46 ppb. (The GC/MS method did not report dry weight. Using an average of percent solids of 0.482, a dry weight would be 95.4 ppb.) (See bioassay photos from reported plant damage Appendix 6).

Appendix 1

Methodology

The study used the following guidelines, as outlined directly by the laboratories:

Sampling Procedures

"All scheduled sampling will be conducted using composite sampling procedures. A composite sample entails the mixing or composting of several sub-samples taken from different locations in the compost pile. Composite sampling will entail the following procedure:

- Sub-samples will be taken from random location in the current final product stockpile.
- Samples will be taken at a depth of 1.5 feet from the surface. A shovel will be used to access a 1.5-foot hole in the pile.
- A one-quart Pyrex glass measuring cup and a stainless steel spoon will be used to retrieve a one-quart sample of compost from the hole. A measuring cup is used to meter out a consistent volume of sample. The sample is subsequently deposited into a five-gallon container. This process is repeated for each of the sampling points.
- After all points have been sampled, the resulting composite sample is mixed well. A sample of the composite is transferred into appropriate sample containers."

Bioassay Laboratory

Compost was mixed 50:50 with peat-based potting mix. A slow release fertilizer was mixed into the potting mix at the rate of 8 oz. per cubic foot. The weight of both compost and potting mix were recorded and their moisture was determined for reporting amount of compost in bioassay mix on a dry weight basis. Moisture was determined by drying sample at 65 C for 48 hours.

The pH and electrical conductivity (EC) of the mixed bioassay media was measure on a 1:5 media to water slurry that had equilibrated for 4 hours. In Phase I the pH of test samples ranged from 6.2 to 7.2 and the EC was low, less than 2dS/m. In Phase II the pH of the test samples ranged from 5.3 to 7.6 and the EC was less than 2 dS/m. The peat control had pH 5.3 and EC 1.3 of dS/m.

Visual assessment and photographs were taken at 21 days after seeds were planted. If plants that scored greater than zero the compost is rated as "fails" in the bioassay.

For each sample, six pots were filled with the bioassay mix, two 6"-diameter pots and four 4"-diameter pots. The 6" pots were planted with four bean seeds each. Two of the 4" pots were planted with four pea seeds each and the other two were planted with six red clover seeds. Plants were watered by hand three times per week. The greenhouse temperature was set for 70 F day, 65 F nights. No artificial light was provided. On the 20th day after planting, visual assessment of herbicide symptoms was recorded and photos were taken. The scale for visual assessment was: 0= healthy, 1= slight leaf curling/cupping, 2= moderate leaf curling, apical meristem abnormal, swollen stems present, 3= severe leaf curling or twisting of stem or petioles, and 4= death. (See photos for examples)

The negative controls were potting mix only and the two positive controls amended with activated charcoal (5% w/w charcoal added to bioassay mix). Charcoal binds with clopyralid and has eliminated herbicide symptoms in other trials. The activated charcoal used was manufactured by Norit and sold through Wilbur-Ellis Co., Portland. In Phase I and Phase II the control responded as expected; the positive control exhibited herbicide damage and the negative control did not.

Analytical Laboratory I

The laboratory used the EPA Method 8151A for analysis of clopyralid in compost. The samples are sonicated in methylene chloride/acentone, turned into a derivative compound with diazomethane, and cleaned to remove matrix interferences with SPE (solid phase extraction) carbon filters. Since the compost matrix contains many GC interferences, after analysis using a dual column GC/ECD, any potentially positive results are reevaluated after analyzing the sample a second time using an alternative temperature program.

Analytical Laboratory II

Laboratory II conducted analysis for Phase II samples. The laboratory developed a method which it referred to as Meth-151 Revision #2, also known as GC/MS. This method was developed in collaboration with Dow AgroScriences, which has an LOQ of 1ppb and an estimated LOD of 0.3ppd. The GC analysis included preparing a seven-point standard curve by injecting constant volumes of standard solutions. Use constant volume injections of sample extracts as well. Sample responses not bracketed by the standard curve require dilution and reinjection. Inject a curve check standard every 4-5 sample injections. All standard solutions injected are incorporated into the standard curve generated.

Contractors Involved in Study

Technical Assistance and Sample Collection

NEEK Engineering, Inc.
7150 SW Hampton St., Suite 222
Tigard, OR 97223

Seed Germination Bioassay Laboratory

Washington State University
Department of Crop and Soil Science
P.O. Box 6464
Pullman, Washington 99164-6420

Analytical Laboratories

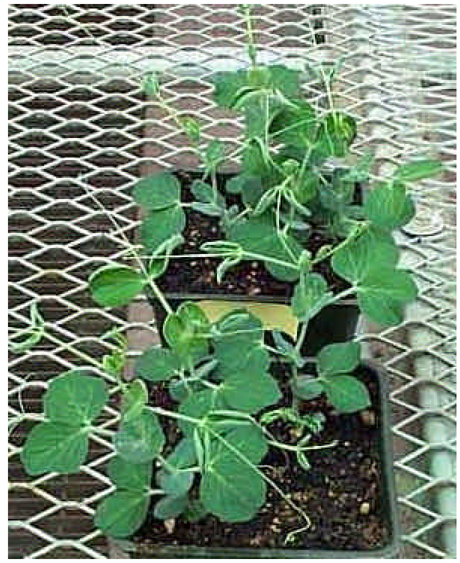
Morse Laboratories, Inc.
1525 Fulton Avenue
Sacramento, CA 95825

ToxScan Inc.
42 Hangar Way
Watsonville, CA 95076-2404

Appendix 2

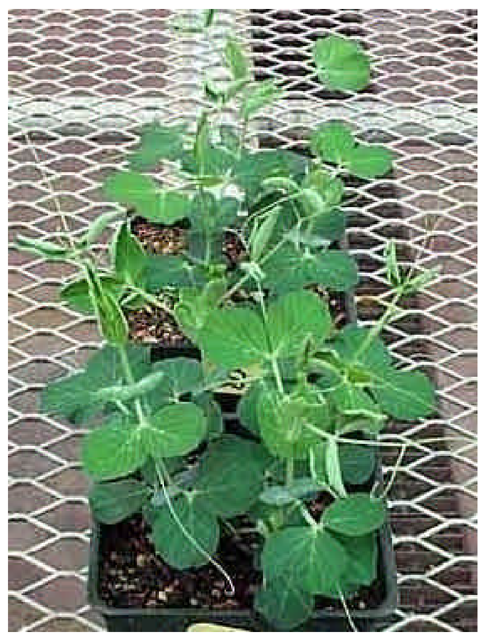
Photos of Plants From the Bioassay Test Phase II

Control no clopyralid



GC/MS method - 94 ppb dry weight

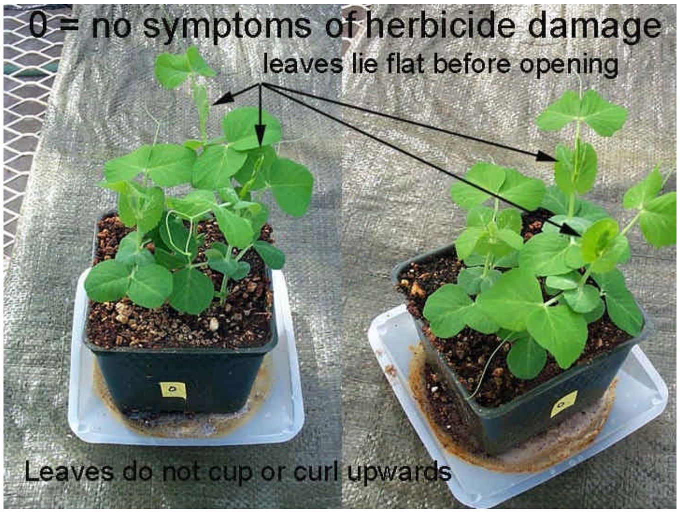
GC/MS method - 36 ppb dry weight

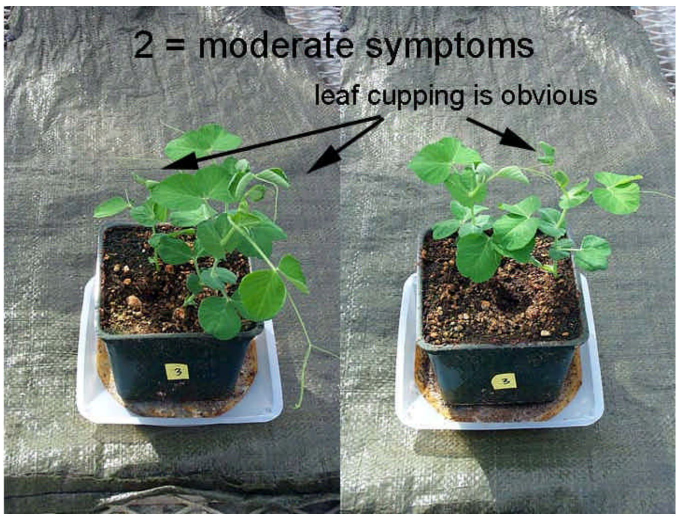


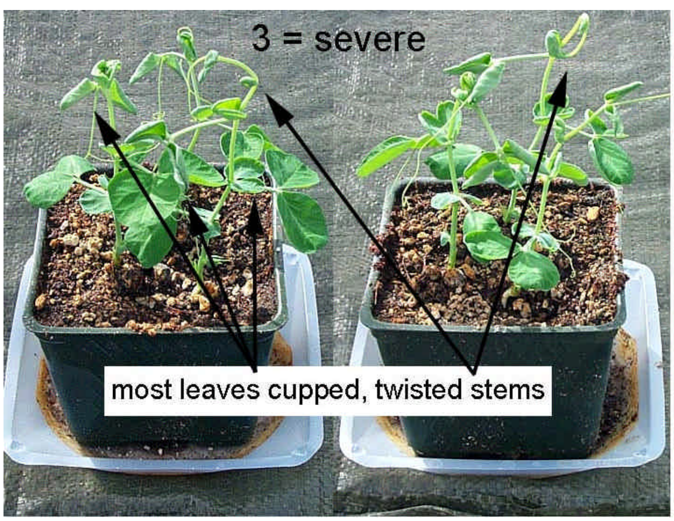
CG/MS method - 25 ppb dry weight

Appendix 3

Examples of Bioassay Visual Scoring







The scale for the visual assessment of herbicide symptoms:

0 = healthy

1 = slight leaf curling/ cupping

2= moderate leaf curling, apical meristem abnormal, swollen stems present

3 = severe leaf curling or twisting of stem or petioles

4 = death

Appendix 4

Excerpts from “Dow AgroSciences, Clopyralid, A North American Technical Profile”.

The following information is provided as a brief discussion of the properties of clopyralid. Dow AgroSciences, Clopyralid, A North American Technical Profile, July 1998, provides an in-depth review of the active ingredient clopyralid.

Purpose:
Clopyralid is a growth regulator herbicide discovered in 1961. Since the initial launch in Europe in the mid to late 1970’s. clopyralid has been used effectively for control of annual and perennial broadleaf weeds in certain crops and turf. Clopyralid also provides effective control of certain brush species on rangeland and pastures.

General Information:
Clopyralid is active when applied preemergence, preplant incorporated or post emergence. The activity of clopyralid on weeds (annuals and perennials) may vary by type of application. For instance, only post emergence applications of clopyralid provide effective control of perennials. It has a relatively narrow spectrum of activity being particularly effective against members of four specific broadleaf weed families:

Asteraceae (such as sunflower, cocklebur, ragweed, chicory, scent less chamomile, sagebrush, Canada thistle, knapweed, dandelion, and perennial sow-thistle);
Fabaceae (such as clover, black medic, vetch, mesquite);
Solanaceae (such as nightshade, jimsonweed);
Polygonaceae (buckwheat)

Toxicity to Plants

Dow AgroSciences has provided a list of plant species that are tolerant to clopyralid, based on data from tests using direct sprays at typical use rates These include agricultural crops such as asparagus, corn, mint, wheat, and several grasses; and several ornamental shrubs and trees. These plants are listed on various product labels containing clopyralid.

However, clopyralid exhibits phytotoxicity (toxicity to plants) at levels below ten parts per billion (ppb) to several common vegetables, including plants in the legume (e.g., peas, beans), solanaceous (e.g., tomatoes, potatoes) and aster (e.g., sunflower) families.

Toxicity to Humans

Dow AgroSciences, the primary registrant, has submitted to U.S. EPA adequate studies to permit a complete toxicological evaluation of clopyralid. The results from animal test conducted with technical grade and formulated clopyralid products indicate clopyralid fits the U.S. EPA acute toxicity category of III (slight toxicity); that is low mammalian toxicity would be expected from a single dose exposure. Exposure to clopyralid via dermal, inhalation or oral routes is not expected to result in any significant adverse health effects for humans. Longer-term animal studies indicate that clopyralid does not demonstrate chronic toxicity, oncogenicity or adverse reproductive effects. Other toxicity studies demonstrate exposure to clopyralid is not expected to result in gene mutation or have effects on chromosomes.

Fate of Clopyralid in Soil and Compost

Half-life of Clopyralid.- The degradation of clopyralid in the environment is determined by its physical-chemical properties and the metabolism by soil microbes. Clopyralid is readily soluble in water. It is not susceptible to breakdown by sunlight and hydrolysis and has low volatility. In water, with or without exposure to sunlight, clopyralid has a half-life of greater than 30 days. The amount of water present and temperature influence soil microbe activity that determines the rate of degradation of clopyralid in soil.

Dow AgroSciences conducted laboratory studies on the impact of soil moisture and temperature on clopyralid degradation in soil (Clopyralid—A North American Technical Profile, October 1997). Under aerobic conditions, degradation increases in warm moist soils. Laboratory studies were conducted with 19 different U.S., Canadian, and European soils under warm (25 degree Celsius) and moist conditions. Clopyralid half-life averaged 28 days (range 8-250 days). When soil temperature decreased, (10 degrees Celsius), degradation slowed to an average half-life of 64 days in six soil types. Studies conducted at higher soil temperatures (30-35 degrees Celsius) demonstrated an average half-life of 19 days. Degradation slowed down in water logged soils or anaerobic soil conditions; clopyralid half-lives were greater than 365 days.

Under field conditions, degradation rates similar to those in laboratory studies were observed, with an average half-life of 25 days (range 8-66 days) at 20 sites.

It is unknown how these data apply to the decomposition of clopyralid in compost; no research studies have yet been obtained. There is evidence that, unlike other herbicides that generally break down in composting, the group of herbicides that includes clopyralid (chlorinated pyridine carboxylic acid herbicides) break down only very slowly during composting. Vandervoot et al. Found clopyralid levels decreased from 32 ppm to 1.4 ppm after one year of composting grass clippings. (Verndervoot C., Zabik M.J., Branham B., Lickfeldt D.W. (1997) Fate of selected pesticides applied to turfgrass: Effects of composting on residues. Bull Environ. Cantan. Toxocol 58:38-45.) However, this is more than 100 times the level that can damage susceptible plants.

Current Research

Dow AgroSciences is currently conducting three research projects to ascertain the relationship between clopyralid and compost. These studies will determine:

1. Impact of product formulation and mowing regimes on residue of clopyralid to determine if there are technology changes or management practices that could be adopted to reduce residues entering municipal/commercial compost;(see list of studies).
2. What compost practices can be adopted to improve/increase the degradation of clopyralid in compost; and
3. What types of remediation measures might be used on compost piles containing clopyralid.

As part of these studies, the half-life of clopyralid in compost will be determined. The remediation study will investigate methods to allow more rapid decompositation of clopyralid in compost, including different moisture levels, mixing of soil with compost, and the addition of microbes during composting. Dow AgroSciences indicated that final results should be available in 2002/2003 and that the findings will be published in a journal.

Mode of Action and Symptomology

Clopyralid is a synthetic form of natural plant growth hormones called auxins. It disrupts plant growth processes by binding at the receptor sites normally used by the plant's natural growth hormones. This binding causes unproductive and abnormal plant growth resulting in plant death. Plants die in a few days or, in the case of some perennial weeds, the process may continue for a longer period. Plant uptake of clopyralid occurs through both roots and leaves.

Whether clopyralid enters the plant through the leaves or roots has only a slight impact on the resulting plant symptomology. The symptoms shown by annual and perennial weeds are similar, but the degree of control may differ. For example, established Canada thistle plants intercept enough foliar clopyralid to result in the death of top-growth and roots. However, when clopyralid is soil applied, the roots of Canada thistle intercept only enough clopyralid to cause symptom but not death. In contrast, however, clopyralid applied premergence sometimes kills germinating seedlings before emergence.

The symptoms of clopyralid activity include:
* root and shoot inhibition
* thickened roots nad inhibited root and hair prodiction
* thickened, curved, twisted shoots, stems and leaves
* parallel venation (narrow leaves with callus tissue)
* cupping and crinkling of leaves
* callus (hardened) growth on stems
* stem cracking
* proliferated growth

Uptake (absorption) and Translocation Characteristics

Uptake - As a soil-applied preemergence compound, clopyralid becomes a component of the soil solution and enters the plant primarily through plant roots although some clopuralid may also enter the plant through emerging shoots. As a foliar treatment. Clopyralid is rapidly absorbed through leaves. As a result, clopyralid typically needs a brief (2 hours) rain free period after foliar application.

Foliar uptake of clopyralid is influenced by relative humidity as well as the stage of the weeds a application. Rate of foliar absorption is increased under higher humidity conditions and when applied to vegetative as opposed to flowering plant.

Translocation - Once absorbed, clopyralid moves readily throughout the plant via both the xylem (water-transporting) and phloem (nutrient transporting) system of the plant. Clopyralid is distributed throughout the entire plant to the meristems (growing points) and other developing plant parts. Eventually, lethal amounts of clopyralid accumulate in the meristem and result in plant death.

Uptake of clopyralid through roots continues even after the emergence providing residual control of weed seedlings that may germinate after treatment. Foliar applied clopyralid translocates rapidly form treated leaves to the shoot apex and the roots. The chemical accumulates primarily in the shot meristems, especially in the upper shoot. Rapid translocation through the phloem to roots enables foliar applications of clopyralid to control deep-rooted perennials like Canada thistle.

Factors that impact plant growth also impact translocation of clopyralid and thus, clopyralid performance. Disruption of the plants metabolism will reduce the amount of herbicide translocated to the meristems. Environmental conditions that are not conductive to active plant growth may reduce translocation and result in reduced herbicidal activity, while normal growing conditions result in optimum control. However, the rapid translocation of clopyralid can mean better performance under certain conditions. For instance, its rapid translocation enables clopyralid to reach the roots of perennials and continue working even if the shoot is killed by frost, mowing or cultivation.

Environmental Risk

According to the EPA methodology used to identify potential environmental risk, clopyralid has little likelihood of negatively impacting birds, mammals, fish and aquatic and terrestrial invertebrates. There may be potential risk to terrestrial plants, which is not unexpected since clopyralid was selected for its herbicidal properties.

Appendix 5

Letter to the DEQ Solid Waste Advisory Committee (SWAC) from a concerned property owner

8/21/02

Members of the SWAC, thank you for the opportunity to speak to you today.

I have been an avid organic gardener of edibles and ornamentals for more than 27 years and was a Master Gardener for nearly 10 years. I started and ran Metro's Home Composting Demonstration Program beginning in 1989, followed a few years later with the Alternatives to Pesticides Program, which are now combined as Metro's Natural Gardening workshops. I am currently the Resource Conservation Specialist for Portland Public Schools, working to save resources for the district and to educate students and staff about natural systems. I am addressing to you today as a private citizen, not a representative of the district.

I recently realized my life-long dream when I bought 5 acres in Sandy a year ago. The first order of business was to begin adding compost to build the tilth of the soil. I bought 10 yards of yard debris compost and began spreading it throughout my gardens, both as a top dressing around established plantings and mixing it into the soil in new and renovated beds. I planted $100 worth of organic vegetable and flower starts, $20 worth of seeds, and $50 of perennials. I planted tomatoes, peppers, eggplants, beans, peas, sunflowers, dahlias, cosmos, zinnias, and more. The cow ate the perennials. The compost ate the starts and seeds.

Some weeks after spreading the compost, I talked with my neighbors, John Gardiner and Christine Perala Gardiner who had also purchased 10 yards of compost from the same company at my recommendation. They noted serious deformities and obvious stress among their plantings. Comparing notes, we discovered our gardens were experiencing similar devastation: stunted plants and crops, cupping leaves, general failure to thrive. On further investigation, Christine and John identified the problem as Clopyralid present in the product. The company we purchased the product from said they conducted bioassay tests regularly. Somehow they must have missed this batch. I understand they tested it after we complained and found it contained Clopyralid at up to 80 parts per billion. I have attached photos of some of my plants showing their stressed and stunted condition.

I have several concerns about Clopyralid in commercial yard debris compost. Home gardeners diligently purchase and use commercially prepared yard debris compost to improve their soil. As an committed organic gardener, I have now contaminated all my planting beds, nearly a half acre, with a persistent herbicide. Not only is this year's vegetable crop ruined, but I have no way to know how long the soil will stay contaminated and I am afraid I have no good options for decontaminating it. As you can imagine, I'm not in a hurry to purchase more compost in an effort to dilute what's there. I spread it among existing plantings, so removal is an expensive and very labor-intensive effort. Manure-based composts are suspect because the herbicide passes through cows. I don't trust any commercial compost now, knowing that Clopyralid is still available for use by the home gardener and landscaping companies. Activated charcoal is the prescribed treatment, but it is not one that can be readily implemented. It is a nasty product, requiring substantial protective gear for the applicator including a respirator and full body protection from the dust, and it must be applied on a windless day. This is not a practical solution. So, one concern is that commercial compost is not to be trusted.

Another concern is the impact to existing solid waste infrastructure in the state. If the final product cannot be sold, why collect yard debris at all? Municipal yard debris collection programs and composting operations throughout the state are at risk. This speaks directly to the ability of DEQ to achieve its waste reduction goals, not to mention the financial impact to haulers, local governments, businesses and customers who have already financed the infrastructure to collect and compost this resource.

A third concern is the impact to infrastructure in development now. Both Portland and Metro have committed significant resources to develop a municipal food composting system in the region. The selected processor, NorCal, is reluctant to use yard debris as a bulking agent in the system they are trying to set up based on the horrific problems they encountered in Spokane. Without yard debris, what other significant source of carbon exists? And what alternative carbon source exists in sufficient volume to keep the organics tip fee lower than landfilling? Does this mean the organics effort is dead before it starts? Portland Public Schools has hired 7 people to begin building the infrastructure to separate organics in the cafeterias and kitchens in the elementary schools and central kitchen this fall. PPS believes in this effort as a waste reduction strategy, a fiscally responsible strategy, and an effective resource management strategy.

The presence of Clopyralid in any commercially available compost renders it undesirable and unsaleable. The <u>potential</u> presence renders <u>all</u> commercial compost suspect. Home gardeners are left with few, if any, good options. As an organic gardener, I have suffered a serious blow: I have lost my crop, contaminated my soil for an undetermined amount of time, have no viable options for remediation, and have no practical options for improving my soil in the future. I have been harmed, certainly, but more than that, I believe there is a bigger problem that must be boldly and promptly addressed.

I urge members of this committee to carefully consider all the impacts of this persistent herbicide. I urge you to go beyond accepting Dow Chemical's proposed label change as sufficient. It is not enough. We should not allow one product to endanger an entire infrastructure. That is lousy and dangerous policy.

Thank you for your time and your attention to this urgent problem.

Nancy Bond

Appendix 6

Photos of Reported Plant Damage

Test Compost

Bean – apical meristem twisted, trifoliate leaf curled tight and will not open.

Pea very obvious cupped leaves.

Red clover seedlings are twisted with very cupped leaves.

Appendix 7

List of Sensitive and Tolerant Plants - provided by Dow AgroSciences

SENSITIVE PLANT

Families
legumes, solanaceous, composite

Some Sensitive Plants*

Peas	Asters
Beans	Carnation
Lentils	Lupine
Carrot	Dandelion
Lettuce	Clover
Potato	Cotton (Upland)
Tomato	Thistle
Common Buckwheat	Sunflower

PLANT SPECIES TOLERANT TO CLOPYRALID

Use Site and/or Plant Species Tolerant to Applications of Clopyralid

Asparagus	Grass gr. for sod
Barley	Industrial & storage sites
Christmas trees	Mint
Corn,field	Non-cropland
Conttonwood trees	Oats
CRP acres	Oilseed rape
Dicondra turf	Permanent pastures
Dicondra gr. for seed	Poplar trees
Eucalyptus trees	Rangeland
Fallow cropland	Rights-of-way
Forestry	Sugar beets
Grass gr. for seed	Wheat

Information Provided by Dow AgroSciences
**Note: Dow has not confirmed that this is a complete list.*
Distributed by DEQ, May 2002

ORNAMENTALS TOLERANT TO CLOPYRALID

Apple, Nonbearing	*malus species*
Arborvitae	*thuja occidentalis*
Azalea	*rhododendron obtusum*
Boxwood Little leaf	*buxus microphylla*
Cinquefoil	*potentilla fruticosa*
Dogwood, Flowering	*cornus florida*
Fir, Balsam	*abies balsamea*
Fir, Douglas	*pseudotsuga menziesii*
Fir, Fraser	*abies fraseri*
Fir, Grand	*abies grandis*
Fir, Noble	*abies procera*
Juniper, Blue Rug	*juniperus horizontalis*
Juniper, Blue Star	*juniperus squamata*
Juniper, Shore	*juniperus conferta*
Maple, Red	*acer rubrum*
Oak, Red	*quercus rubra*
Oak Willow	*quercus phellos*
Pine, Lodgepole	*pinus contorta*
Pine, Mugho-Mugho	*pinus mugh*
Pine, Ponderosa	*pinus ponderosa*
Pine, Scotch	*scotch pinus strobus*
Pine, White	*pinus sp.*
Rhododendron	*rhododendron species*
Spiraea	*spiraea bumalda*
Spruce, Colorado Blue	*picea pungens*
Spruce, Norway	*picea abies*
Spruce, White	*picea glauca*
Sycamore, American	*platanus occidentalis*
Walnut, Black Nonbrg.	*juglans nigra*
Yew	*taxus media*

TURFGRASS TOLERANT TO CLOPYRALID

Bahiagrass	*paspalum notatum*
Bentgrass	*agrostis species*
Burmudagrass	*cynodon species*
Buffalograss	*buchloe dactyloides*
Centipedegrass	*eremochloa ophiuroides*
Fescues	*festuca species*
Kentucky bluegrass	*poa pratensis*
Ryegrass	*lolium perenne*
Zoysiagrass	*zoysia species*

Appendix 8

2002 - PESTICIDE PRODUCTS CONTAINING CLOPYRALID*

Name	EPA Number	Ingredient	Use	Registrant Name
Battleship Herbicide	228-371-5905	Clopyralid	Non Ag	Helena Chemical Company
Confront Specialty Herbicide	62719-92	Clopyralid	Non Ag	Dow Agrosciences Company
Curtail	62719-48	Clopyralid	Ag	Dow Agrosciences Company
Curtail M	62719-86	Clopyralid	Ag	Dow Agrosciences Company
Greenview Preen’n Green Lawns	961-390	Clopyralid	Non Ag	Lebanon Seaboard Chemical Corp.
Howard Johnson’s Weed & Feed w/ Millenium Ultra	228-343-32802	Clopyralid	Non Ag	Howard Johnson’s ENT
Lesco Momentum Premium Selective Herbicide	228-321-10404	Clopyralid	Non Ag	Lesco, Inc.
Lontrel Turf and Ornamental	62719-305	Clopyralid	Non Ag	Dow Agrosciences, LLC
Millennium Ultra Selective Herbicide	228+322-17545	Clopyralid	Non Ag	Monterey Chemical Co.
Momentum Premium Weed & Feed 21-0-12	228-340-10404	Clopyralid	Non Ag	Lesco, Inc.
Redeem R&P	62719-334	Clopyralid	Ag	Dow Agrosciences, LLC
Riverdale Millennium Ultra Plus	228-382	Clopyralid	Non Ag	Riverdale Chemical Co.
Riverdale Millennium Ultra Selective Herbicide	228-322	Clopyralid	Non Ag	Riverdale Chemical Co.
Riverdale Trupower Selective Herbicide	228-323	Clopyralid	Non Ag	Riverdale Chemical Co.
Spring Valley Weed & Feed w/ Millenium Ultra 20-3-5	228-343-41124	Clopyralid	Non Ag	Vogel Seed & Fertilizer
Stinger	62719-73	Clopyralid	Ag	Dow Agrosciences, LLC
Strike Three Ultra	228-374-1381	Clopyralid	Non Ag	Agriliance, LLC
Tee Time 18-5-9 w/ Millennium Ultra Herbicide	228-343-9198	Clopyralid	Non Ag	The Andersons
The Andersons 16-4-8 w/ Millennium Ultra Herbicide & PCSCU	228-343-9198	Clopyralid	Non Ag	The Andersons
Transline Herbicide	62719-259	Clopyralid	Ag	Dow Agrosciences, LLC
UHS Chaser	228-372-65783	Clopyralid	Non Ag	United Horticultural Supply

*Pesticide Product Registered in 2002

Appendix 9

List of Clopyralid Studies

Washington State Garden Demonstration Plots
http://www.puyallup.wsu.edu/soilmgmt/ClopyrGarden.htm

Washington State University Clopyralid Dissipation in Turf Grass Clippings
http://www.puyallup.wsu.edu/soilmgmt/Abstracts&Pubs/ClopyralidTurfgrass.pdf

Washington State University Greenhouse Trail with Clopyralid –Sesnistive Garden Plants
http://www.puyallup.wsu.edu/soilmgmt/ClopyrBigPot2.htm

Woods End Study Composting News http://www.deq.state.or.us/wmc/solwaste/composting.html