Data Evaluation Report on the aquatic field dissipation of penoxsulam

PMRA Submission Number {......} EPA MRID Number 46930301

Data Requirement: PMRA Data Code:
EPA DP Barcode: D333302
OECD Data Point:
EPA Guideline: Non-Guideline Composting Stud

Test material: Penoxsulam **Concentration of a.i.:** not provided

End Use Product name: not provided **Formulation type:** not provided

Test material:

Common name:	Penoxsulam.
Chemical name:	
IUPAC name:	3-(2,2-Difluoroethoxy)-N-(5,8-dimethoxy[1,2,4]triazolo[1,5-c]pyrimidin-2-yl)-α,α,α-trifluorotoluene-sulfonamide. 2-(2,2-Difluoroethoxy)-N-(5,8-dimethoxy[1,2,4]triazolo[1,5-c]pyrimidin-2-yl)-6-(trifluoromethyl)benzenesulfonamide. 6-(2,2-Difluoroethoxy)-N-(5,8-dimethoxy-s-triazolo[1,5-c]pyrimidin-2-yl)-α,α,α-trifluoro-o-toluenesulfonamide.
CAS name:	2-(2,2-Difluoroethoxy)-N-(5,8-dimethoxy[1,2,4]triazolo[1,5-c]pyrimidin-2-yl)-6-(trifluoromethyl)benzenesulfonamide.
CAS No.:	219714-96-2.
Synonyms:	XDE-638; DE-638; TSN101649; SP1019 (SePRO).
Smiles string:	FC(c1cccc(c1S(=O)(=O)N(c1nn2c(n1)ccnc2))OCC(F)F)(F)F (ISIS v2.3/Universal SMILES). No EPI Suite, v3.12 SMILES String found as of 6/27/06. n1c(nc2n1c(ncc2OC)OC)NS(=O)(=O)c3c(cccc3C(F)(F)F)OCC(F)F.

Reviewer: Lucy Shanaman
EPA Reviewer

Signature: Lucy Shanaman
Date: April 27, 2007

Peer Reviewer: James Hetrick, Ph.D.
EPA Reviewer

Signature: James A Hetrick
Date: 4/30/07

Company Code
Active Code
Use Site Category
EPA PC Code: 119031

CITATION: Roberts, D. W., Brinton, W. F., Evans, W. F. Penoxsulam Herbicide in Turfgrass, Compost and Compost/Soil Growth Media: Environmental Fate and Non-Target Plant Effects. Unpublished study performed by Regulatory Laboratories – Indianapolis Lab, Dow

2061791

AgroSciences LLC, 9330 Zionsville Road, Indianapolis, Indiana 46268-1054. Laboratory Study ID: 050015. Experiment initiation March 24, 2005 and completion July 14, 2006 (p. 4). Final report issued July 14, 2006.

EXECUTIVE SUMMARY

Penoxsulam (3-(2,2-difluoroethoxy)-N-(5,8-dimethoxy[1,2,4]triazolo[1,5-c]pyrimidin-2-yl)-α,α,α-trifluorotoluene-2-sulfonamide) was applied once by either fertilizer-granular or soluble concentrate formulations at 0.022 or 0.067 lbs. (a.i.)/acre to mature Kentucky bluegrass (*Poa pratensis*) in Pennsylvania. Turfgrass clippings were collected 21 days post treatment to determine the rate of decline of penoxsulam in turfgrass. The two formulations were sampled at 5 days post treatment. These turf clippings were mixed with deciduous leaves to generate a typical yard waste mixture, and composted at an average temperature of about 40° C. In the low fertilizer-granular treatment rate compost, fertilizer-granular penoxsulam residues declined from 3,063 ppb to 4.63 ppb over 21 days. In the high rate fertilizer-granular treatment formulation compost, penoxsulam declined from 3,814 ppb to 7.92 ppb. For the low rate soluble concentrate formulation compost, fertilizer-granular penoxsulam residues declined from 14,974 ppb to 6.99 ppb over 21 days. For the high rate soluble concentrate formulation compost, penoxsulam declined from 30,434 ppb to 20.47 ppb, over 21 days. For all treatments, penoxsulam declined on the leaf blade portion of growing turf grass with a first-order foliar dissipation half-life of 13 to 14 days. The main route of dissipation in turf appears to be associated with foliar wash-off

Turfgrass clippings from the penoxsulam fertilizer-granular treatment formulation and the soluble concentrate were utilized for the compost dissipation study. Over 160 days of composting penoxsulam, dissipation was first-order with a dissipation half-life of 39 to 42 days. Small differences in observed dissipation rates can be attributed to experimental design. Initially, small, bench size composting chambers were used. Later in the experiment, larger 120 liter units were used.

Carbon to nitrogen ratios (C:N) varied between 15 and 42, indicating an acceptable level of microbial activity. After 90 days, the composts were mixed with loam soil at volumes of 12% and 33% to test adverse effects by measuring fresh plant weight of sugar beets, onions, snap beans, tomatoes, petunias and dwarf sunflowers at 28 day post planting. The bioassay data indicated the presence of adverse effects for sugar beets, the most sensitive species tested. Additionally, onion weight was at 91% of the control weight at one sampling interval, and sugar beets were at an average of 88.4% of the controls at two sampling intervals. Sugar beets also displayed a reduced percent of germination compared to the control at some test concentrations.

Study Acceptability: This non-guideline study is classified supplemental. While there were no significant deviations from good scientific practices, tabulated data for the bioassay studies would have assisted in analyzing the extent of adverse effects to sugar beets.

MATERIALS AND METHODS

Field Phase

Composting feedstock was produced using penoxsulam soluble concentrate and fertilizer-granular treatment formulation on turfgrass plots at 0.022 and 0.067 lbs. (a.i.)/acre.

Test Site Description

The test sites consisting of Trexler shale-silt loam soil were located at the Crop Management Strategies, Inc research farm in Germantown, PA. The test site, which were planted with Kentucky bluegrass (*Poa pratensis*) mixture including Unique, Midnight and Blacksburg cultivars, had less than a 2% slope, and sufficient buffer to preclude runoff between plots. A new rotary mower (Honda model HRR216PDA) was used with the mulching blade removed. The entire area was mowed, and the clippings removed, on May 3, 11, 17 and either May 24 or May 24. Untreated turfgrass was harvested from the test site before the study began.

Test Substance Application

Test substances were stored at between 8.9° and 25° C until applied. Application of the granular formulation was made with a Gandy Model 42 drop spreader with a 42 inch swath and with a hand held spin spreader to compensate for differences between application rate of control and test substances at 106% to 110% of the target application rate. Application of the liquid formulation was made using a tractor mounted sprayer with a 15 gallon cone tank, bypass agitation and a 4 nozzle boom with XRI1005VS flat fan tips and a 50 mesh check valve screens with water (pH: 5.8, hardness: 50 ppm) used as the carrier fluid.

Bulk Plot Sample Collection and Handling

A control sample was collected by mowing at a 5 cm height, and bagging the clippings for use in feedstock, before penoxsulam was applied. The control sample was shipped the same day in HDPE pails with snap top lids, at ambient temperatures to Woods End Research Lab. Treated samples used for feedstock were stored and shipped in the same manner. All samples that were used to test for penoxsulam residues were placed in zip lock bags, and frozen until shipment to Carbon Dynamics Institute LLC on June 7, 2005.

The mower was cleaned and clean catch bags were used for each collection. Irrigation was applied as needed. Total irrigation and rainfall was either 1.44 or 1.20 inches for each plot.

Decline Plot Sample Collection

PVC pipe was used to construct a 5 foot by 7 foot PVC frame in the center of each of the four sample subplots. The perimeter around the frame was mowed at a 1.5 inch height, and the clippings discarded. The turf within the 5 foot by 7 foot frame was mowed at a 2 inch height, and the clippings collected for sampling. The mower collection bag was removed after the mower had been moved to sit on a plastic sheet. The mower was cleaned of clippings which were collected in a plastic bag, sealed with a twist tie to prevent moisture loss, and placed into a cooler with ice packs. The mower was cleaned with an Alconox (detergent) solution, rinsed and allowed to dry between collections.

Day 0 samples were collected about 4 hours after application in order to allow time for the herbicide to dry on the leaf surfaces. Before each subsequent sampling event, irrigation was applied to supplement rainfall to achieve a total of 1.0 inches of water.

Decline Plot Sample handling

After sample collection, a fresh weight mass was obtained by weighing on a triple beam balance in a field laboratory. One 50 gram sample was collected in a zip lock bag and held under frozen storage until residue analysis. A second gram sample was collected, and placed in a drying oven at 49° C for the initial 3 samples, and 71° C for the final two samples for 3 to 5 days until no further weight loss. Frozen samples were packed in dry ice, and shipped to Carbon Dynamics Institute LLC for residue analysis. Penoxsulam concentration was converted to dry weight concentration. The penoxsulam detection limit was 0.10 µg/kg (ppb).

Composting, Utilization and Bioassay Phases

Compost was prepared by blending fresh clippings from the field phase with dry leaves, generally northern red oak. Clippings were stored at 4° C until composted. Analytical results from the Woods End Research Lab were used with their algorithm to achieve a target C:N ratio of 30:1. The grass portions of this mixture typically contained 33% treated clippings to represent an extreme scenario with maximum market share for penoxsulam. It was assumed that a maximum of 33% of the herbicide market could be penoxsulam, so 33% of the plot was treated with penoxsulam to simulate random mixing clippings from a community where 33% of the lawns were treated with penoxsulam. The bottom of each 120 liter plastic barrel was perforated with 100 ¼ inch holes. A ½ inch mesh screen was fitted 2 cm above the barrels to provide for air circulation. The walls and lid of the barrel was insulated with Styrofoam with an insulating value of about R=10. After day 32 of composting, the compost was transferred to 4.5 liter super insulated Dewar flasks in order to maintain the average 40° C composting temperature for the remainder of the composting phase. Dickerson data-log thermometers were placed in the center of the compost in the Dewar flasks to measure temperature. After composting had begun, the temperature of the composting fluctuated between 40° and 60° C for the first 12 days, and between 30° and 40° C for the duration of the study. Oxygen demand was monitored by periodically inserting an O_2 sensing wand into the center of the composting material. The contents of all vessels were mixed on day 3 and day 17, along with the mixing at the day 32 transfer to the super insulated flasks. Barrel numbers were reduced as volume declined, but a minimum of nine 4.5 liter vessels were maintained for the duration of the study. Fifty grams were removed at each sampling interval, frozen and shipped by overnight service to Carbon

Dynamics Institute LLC, in Springfield, IL for analysis. Parallel samples were tested at Woods End Research Lab. Analysis of variance, regression and LDS data analysis was preformed using the STAT Data Analysis Program by G. Periman (1980 Data Analysis Programs for the UNIX Operating System, UCSD).

Utilization and Bioassay

Compost resulting from clippings treated at two treatment levels with penoxsulam was collected at days 95, 123 and 160. The samples were analyzed for penoxsulam residues and evaluated for effects plants using short-term seeding bioassays at two different application rates. Test species include: sugar beets, onion, tomato, bush snap beans, dwarf sunflower and petunias. The loam soil mixed with the compost, and used for controls for these tests was obtained from Seasons Downeast Landscaping, Camden, Maine. A bioassay with the 160 day compost was conducted with the most sensitive species, sugar beets and onions only. All test cultivars were tested with day 90 and day 123 compost.

Quantitative Residue Analysis Phase

Samples of turfgrass clippings and compost were analyzed by Carbon Dynamics Institute, LLC using a DAS method, GRM 01.25, high performance liquid chromatography in tandem with mass spectroscopy, Positive Electrospray Ionization (ESI^+). Individual recovery samples were between 77 and 123% with a standard deviation of 15.4%. The limit of detection was 0.059 µg/kg.

RESULTS AND DISCUSSION

Decline in Turfgrass

Mean clipping yield peaked at day 21, and moisture was adequate throughout the sampling period. Penoxsulam residues in turf grass clippings (dry weight) ranged from 3,063 to 30,434 µg/kg on day 0. While by day 3 penoxsulam in all samples were below 8.2% of the treatment rate, this could have been due to combination of rainfall and irrigation. The first order penoxsulam foliar dissipation half-life in the clippings collected during the field portion of this study was 13 to 14 days. Recovery of penoxsulam from turf treated with the liquid formulation ranged from 20% to 12% through day 21. Recovery of the granular penoxsulam formulation was less than 2%, and might be attributed to placement of the granular formulation in the thatch layer of the turf. The main route of dissipation in turf appears to be associated with foliar wash-off.

Composting Results

After composting had begun, the temperature of the composting fluctuated between 40° and 60° C for the first 12 days, and between 30° and 40° C for the duration of the composting phase. Day 0 samples indicated that the target C:N ratio averaged 39 instead of the target ration of 30. Declining pH values, increasing nitrate content, increasing Solvita® Maturity Index, and cress test-plant performance all indicated that composting had reached completion. The volatile solids loss was consistent with shrinkage of the maturing compost. Nutrient levels were similar in all 160 day compost samples, and typical of levels found in matured compost.

Seeding Bioassay Results

The 160 day bioassay revealed an adverse effect to sugar beets, as indicated by reduced plant weights in beet seedlings grown in some treated composted samples and onion seedlings grown in one of the treated composted samples in the intermediate treatment rate media. Adverse effects were not reported for sugar beets grown in media derived from clippings collected with lower penoxsulam rates. Insufficient data was provided to determine the probable cause of the observed effect. Sugar beet seedling weights were less than 88% different from the weights in the control compost. Seed germination rates in the four remaining plant groups tested were not significantly different than rates from the control media.

Quantitative Analysis Results of the Compost Phase

Penoxsulam residues in the day 95 compost ranged between 0.059 ppb and 0.221 ppb. Statistically significant differences from the control samples were only reported for day 0 composting samples. The day 31 penoxsulam levels were significantly lower than the day 0 samples. By day 59 of composting penoxsulam residues were below the analytical method limit of quantification. Day 123 and day 160 penoxsulam residue levels corresponded to those in the control samples.

STUDY DEFICIENCIES

1. Insufficient raw data, in tabulated form, was not provided for the bioassay portion of this study. As a result, it is not possible to evaluate the cause or the extent of the adverse effects reported for the sugar beet portion of the bioassay.

2. The stability of penoxsulam in turf clippings could not be confirmed because the storage stability study was not conducted using control samples from the test site fortified at a known concentration and stored frozen for the maximum length of storage of the test samples. Separate stability studies were conducted with penoxsulam and its transformation products in water samples (MRID 46433901) and soil samples (MRID 46433902) obtained from California, but not in either fresh turf clippings or in compost.

3. Degradation products of penoxsulam were not tested for in either the turf clippings or in the resulting compost.

4. A material balance was not determined for penoxsulam and penoxsulam degradation product residues. As a result, while the bioassay does provide useful information concerning the herbicidal activity of composted penoxsulam, the residue half-life calculated in turf clippings is of questionable quantitative value beyond its use as a lower bounding value for residue dissipation in turfgrass clippings.

REVIEWER'S COMMENTS

1. Submitted data from the bioassay portion of this study indicated an adverse effect for sugar beets (the most sensitive species tested) which were exposed to the penoxsulam treated composted turfgrass clippings. However, insufficient data were provided to evaluate the cause or the extent of the adverse effects reported in the sugar beet portion of the bioassay.

2. A complete pesticide use history for the test site was not provided.

3. No attempt was made to determine the formation or decline of penoxsulam degradation products in either the turf grass clippings or the resulting compost.

4. The authors stated that the rainfall plus irrigation applied during the initial sampling intervals of turf grass clippings may have contributed to the rapid drop in measured penoxsulam residues measured at the day 3 and day 7 sampling intervals.

Attachment 1: Penoxsulam Molecular Structure

Penoxsulam [XDE-638; DE-638; TSN101649; SP1019 (SePRO)]

IUPAC Name:	3-(2,2-Difluoroethoxy)-N-(5,8-dimethoxy[1,2,4]triazolo[1,5-c]pyrimidin-2-yl)-α,α,α-trifluorotoluene-sulfonamide. 2-(2,2-Difluoroethoxy)-N-(5,8-dimethoxy[1,2,4]triazolo[1,5-c]pyrimidin-2-yl)-6-(trifluoromethyl)benzenesulfonamide. 6-(2,2-Difluoroethoxy)-N-(5,8-dimethoxy-s-triazolo[1,5-c]pyrimidin-2-yl)-α,α,α-trifluoro-o-toluenesulfonamide.
CAS Name:	2-(2,2-Difluoroethoxy)-N-(5,8-dimethoxy[1,2,4]triazolo[1,5-c]pyrimidin-2-yl)-6-(trifluoromethyl)benzenesulfonamide.
CAS Number:	219714-96-2.
SMILES String:	FC(c1cccc(c1S(=O)(=O)N(c1nn2c(n1)ccnc2))OCC(F)F)(F)F (ISIS v2.3/Universal SMILES). No EPI Suite, v3.12 SMILES String found as of 6/27/06. n1c(nc2n1c(ncc2OC)OC)NS(=O)(=O)c3c(cccc3C(F)(F)F)OCC(F)F.

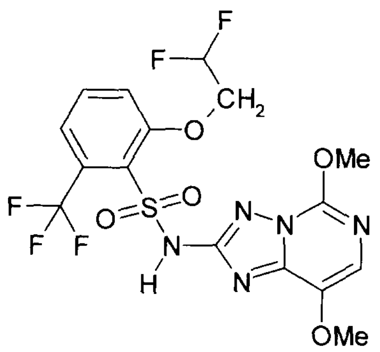


Table 1. Treatment Descriptions

Treatment No.	Source	Formulation	Assay	Rate
B-1	Bulk Plot	FG (GF-1678)	0.014% wt/wt	0.022 lb (ai)/acre
B-2	Bulk Plot	FG (GF-1679)	0.043% wt/wt	0.067 lb (ai)/acre
D-1	Decline Plot	SC (GF-443)	21.4% wt/wt; 239 g(ai)/L	0.022 lb (ai)/acre
D-2	Decline Plot	SC (GF-443)	21.4% wt/wt; 239 g(ai)/L	0.067 lb (ai)/acre
D-3	Decline Plot	FG (GF-1678)	0.014% wt/wt	0.022 lb (ai)/acre
D-4	Decline Plot	FG (GF-1679)	0.043% wt/wt	0.067 lb (ai)/acre

Table 2. Application Time and Conditions

Date	May 25, 2005	May 26, 2005	May 26, 2005
Plots	B-1, B-2	D-1, D-2	D-3, D-4
Time (hr)	1410 - 1515 hr	0739 – 0830 hr	0955 – 1038 hr
Carrier/pH	not applicable	Water/5.8	not applicable
Air Temp (F)	58.2	57.1	62
Soil Temp (F)	56	56	56
Relative Humidity	73	72	63
Soil Moisture	Moist	Moist	Moist
Wind Speed (mph)/Dir	0-1/SW	0-4/N	0-4/N
Sky Condition	100% cover	96% cover	80% cover
Crop Stage	2-in. height	2-in. height	2-in. height

Table 3. Sampling Dates and Times

Date	DAT	Sample Start Time	Sample End Time	Time Into Freezer:
Bulk Plots:				
5/3/05	-22 (Pre-Trt) B-Control	11:30 AM	2:40 PM	Shipped ambient
5/30/05	5			
	B-1	1:30 PM	2:30 PM	4:15 PM
	B-2	2:50 PM	3:30 PM	4:15 PM
Decline Plots:				
5/26/05	0	1:00 PM	5:30 PM	samples 1-6 into freezer at 4:15 PM samples 7-12 into freezer at 6:15 PM
5/29/05	3	10:15 AM	12:40 PM	samples 1-6 into freezer at 11:50 AM samples 7-12 into freezer at 1:20 PM
6/2/05	7	2:00 PM	4:45 PM	5:45 PM
6/9/05	14	3:30 PM	6:05 PM	6:25 PM
6/16/05	21 (D-1, D-2)	11:30 AM	1:15 PM	2:00 PM samples 1-6
6/17/05	21 (D-3, D-4)	11:30 AM	12:30 PM	1:30 PM samples 7-12

Notes:
DAT: Days after treatment.
The sample start time was at the time the first sample was taken from D-1 rep 1.
The end time was at the time the last sample (D-4, rep 3) was placed into the cooler.
Each sample took about 10 minutes to collect.
Samples transported from field to lab in insulated cooler with blue ice.
Plots sampled in numerical order (D-1, D-2, D-3, D-4).
Reps sampled in numerical order.
Samples for FG plots (TRMT 3 and 4, D-3, D4) were collected on 6/17/05 after rain ended sampling on 6/16/05.

Table 4. Weather and Irrigation

Date	Sampling Events (DAT)	Rain (in)	Irrig. (in.)	Total Precip. (in.)	% Normal Precip. (in.)	Air Temperature (F) Min	Max	Mean	% Normal Air Temp. (F)
				Bulk Plot					
25-May	0	0.03		0.03		46	58	52	
26-May		0.00		0.00		53	73	59	
27-May		0.00	0.15	0.15		49	86	66	
28-May		0.50	0.75	1.25		53	83	63	
29-May		0.01		0.01		51	76	60	
30-May	5	0.00		0.00		47	78	60	
Total:		0.54	0.90	1.44	177%				
Mean:						50	76	60	99%
				Decline Plots					
25-May		0.03		0.03		46	58	52	
26-May	0	0.00		0.00		53	73	59	
27-May		0.00	0.60	0.60		49	86	66	
28-May		0.50		0.50		53	83	63	
29-May	3	0.01		0.01		51	76	60	
30-May		0.00		0.00		47	78	60	
31-May		0.00		0.00		50	86	65	
Total:		0.54	0.60	1.14	120%				
Mean:						50	77	61	101%
1-Jun		0.00		0.00		55	87	67	
2-Jun	7	0.00		0.00		52	82	63	
3-Jun		0.30		0.30		55	62	58	
4-Jun		0.06		0.06		60	83	68	
5-Jun		0.00		0.00		60	94	74	
6-Jun		0.39	0.80	1.19		64	95	73	
7-Jun		0.00		0.00		61	91	75	
8-Jun		0.00		0.00		71	100	83	
9-Jun	14	0.35		0.35		64	97	77	
10-Jun		0.12		0.12		69	93	77	
11-Jun		0.01		0.01		72	92	77	
12-Jun		0.00		0.00		69	94	78	
13-Jun		0.00	0.40	0.40		65	98	80	
14-Jun		0.00		0.00		70	95	81	
15-Jun		0.02		0.02		64	88	77	
16-Jun	21	0.24		0.24		57	91	68	
Total:		1.49	1.20	2.69	135%				
Mean:						63	90	74	106%
Grand Total:		2.03	1.80	3.83	130%				
Mean:						59	86	70	107%

30-yr Normals (NOAH Allentown, PA, 1961-1990):

Bulk Plot :

Period	Rainfall	Temp.
May 25-30	0.81	60.3

Decline Plots:

Period	Rainfall	Temp
May 25-31	0.95	60.3
June 1-16	2.00	69.4

Table 5. Concentration of Penoxsulam in Turfgrass 0-21 Days After Treatment

Date	Days After Application	Penoxsulam Conc. As received Basis ppb	Penoxsulam Conc. Dry Weight Basis ppb	Penoxsulam Recovery Dry weight Basis %	Penoxsulam Rec cumm Dry weight Basis %
Plot D-1 (SC, low)					
26-May-05	0	5,395	14,974	19.69	19.69
29-May-05	3	92	274	0.40	20.09
2-Jun-05	7	107	256	0.26	20.35
9-Jun-05	14	5.82	18.53	0.0344	20.38
16-Jun-05	21	2.44	6.99	0.0097	20.39
Plot D-2 (SC, high)					
26-May-05	0	10,591	30,434	10.77	10.77
29-May-05	3	322	890	0.26	11.03
2-Jun-05	7	223	530	0.15	11.18
9-Jun-05	14	18.59	59.17	0.0337	11.21
16-Jun-05	21	7.10	20.47	0.0085	11.22
Plot D-3 (FG, low)					
26-May-05	0	1,088	3,063	1.24	1.24
29-May-05	3	47	131	0.05	1.29
2-Jun-05	7	48	118	0.03	1.32
9-Jun-05	14	6.11	18.87	0.0080	1.33
16-Jun-05	21	1.41	4.63	0.0020	1.33
Plot D-4 (FG, high)					
26-May-05	0	1,318	3,814	1.06	1.06
29-May-05	3	108	297	0.09	1.14
2-Jun-05	7	103	245	0.05	1.19
9-Jun-05	14	17.38	53.20	0.0231	1.21
16-Jun-05	21	2.48	7.92	0.0028	1.22

Table 8. Analytical Methods Employed in Examining Compost Materials

Unit	Analyte or Property	Laboratory Procedure
TS %	Total solids	Over drying at 70°C for 24 hours
VC %	Volatile solids	Oven Loss on Ignition at 550°C
EC ds/m pH –log H^+	Salinity and pH	Saturated paste extract with hydrogen ion electrode/resp. conductivity bridge.
TN %	Total nitrogen	Perkin Elmer TN combustion @945°C
NO_3-N ppm	Nitrate	Ion-specific electrode on water extract
NH_3-N ppm	Ammoniacal nitrogen	Ion-specific electrode on LiCl compost extract
P %	Phosphorus	Molybdate blue for total-phosphate on ash
Mineral %	Ca, Mg, K, Na	Shimadzu AA on acid dissolved ash
Growth %	Cress test	*Lepidium sativa* growth @14days
S-CO_2 S-NH_3	Compost respiration and ammonia release	Solvita test kit on 100cc as-is samples after 24 hr equilibration

Table 9. Composition of Bioassay Media

	Ingredient Volume Proportions, Percent			
		—— Compost designations ——		
Medium Designations	Loam‡	Control	Low	High
Control – 12	78	12	0	0
Low – 12	78	0	12	0
High – 12	78	0	0	12
Control – 33	67	33	0	0
Low – 33	67	0	33	0
High - 33	67	0	0	33

‡ commercial loam analyzed as follows: pH 7.4. CEC 14.1 me/100g. OM 7.3%, Morgan-extractable P, K, Ca, Mg of 213,1587,9713,771 lb/a resp., EC 1.55 dS/M; nitrate-N 16 ppm. Ref. Lab No. 6328.0

Table 10. Plants Used in the Bioassay Trials

Common Name	Latin Name
	Most Sensitive Non-target Species:
Sugarbeet	*Beta vulgaris*
Onion	*Allium cepa*, var. Ailsa Craig
	Moderately Sensitive Non-target Species:
Bush Snap-bean	*Phaseolus vulgaris*, var. Provider
Tomato	*Lycopersicon seculentum*, var. First Lady
	Typical Residential Ornamentals:
Dwarf Sunflower	*Helianthus annus*, var. Teddy Bear
Petunia	*Petunia hybrida*, var. Fantasy Formula, F-1

Table 12. Summary of Compost Properties During 160 Days of Composting

Age Days	Treatment Grass Rate	pH	VS %	TN %	C:N ratio	NH_3-N mg/kg	NO_3-N mg/kg	Solvita Index	Salt EC
0	Control	4.62	92.0	1.30	38	166	–	4.0	1.0
0	Low	4.90	91.9	1.35	37	437	–	3.7	1.1
0	High	5.47	93.0	1.24	42	694	–	3.7	0.8
7	Low	6.02	90.0	1.88	26	697	–	3.0	0.8
7	High	5.74	91.0	1.76	28	718	–	4.0	0.8
28	Low	6.17	86.8	1.75	27	465	–	4.3	0.9
28	High	6.14	88.8	1.65	29	442	–	4.0	0.8
60	Low	6.75	89.4	–	–	440	160	5.7	0.8
60	High	6.49	89.8	–	–	128	138	5.3	0.7
95	Control	6.34	82.8	2.91	15	–	6704	6.0	2.0
95	Low	6.70	86.9	2.51	18	–	248	6.0	0.9
95	High	6.48	85.3	2.81	16	–	235	6.0	1.2
123	Control	6.02	86.3	–	–	–	–	6.0	–
123	Low	6.83	86.4	–	–	–	–	6.0	–
123	High	6.23	87.8	–	–	–	–	5.7	–
160	Control	5.01	83.5	2.38	19	20	3320	7.0	2.1
160	Low	5.77	85.9	2.31	20	54	1935	7.0	1.5
160	High	5.17	85.5	2.28	20	47	2719	7.0	1.6

Note: Grass clippings compost was harvested after grass was treated with either low or high rate of penoxsulam application, or no treatment (control). Values for "low" and "high" are the means of three samples. Values listed for the controls are from single samples.

"– " indicates data not collected

Table 13. Volatile Solids Loss From Compost

Compost Age	Ash, %	VS, %	% VS loss
0	8.2	91.8	-
7	9.5	90.5	14.5
28	12.2	87.8	35.7
60	10.9	89.1	26.8
95	12.9	87.1	39.7
123	12.2	87.8	35.5
160	14.3	85.7	46.4

Note: Samples taken for the duration of the study. Each value is the mean of all compost types and replicate samples.

Table 17. Day-90 Compost Bioassay Germination Results

	No. Germination per Pot †			
Media	Sunflower	Tomato	Bean	Beet
Control -12	4.7	8.7	2.2	6.2
Low -12	4.0	7.3	3.5	5.8
High -12	4.7	7.7	2.5	7.0
Control - 33	4.7	8.2	4.5	7.7
Low - 33	4.3	8.2	5.0	6.8
High - 33	5.0	7.7	4.5	7.3

	Germination as Percent †				
Media	Sunflower	Tomato	Bean	Beet	Mean, All Plants
Control -12	78	87	37	62	66
Low -12	67	73	58	58	64
High -12	78	77	42	70	67
Control - 33	78	82	75	77	78
Low - 33	72	82	83	68	76
High - 33	83	77	75	73	77

†Absence of notations following numbers indicates no statistically significant effects were observed.

Table 18. Day-123 Compost Bioassay Germination Results

	No. Germination per Pot †			
Media	Sunflower	Tomato	Bean	Beet
Control -12	3.3	7.7	1.7	6.7
Low -12	4.3	7.2	1.5	8.7
High -12	3.8	8.2	2.8	7.5
Control - 33	4.7	8.3	3.3	7.3
Low - 33	4.3	7.7	3.7	6.3
High - 33	3.8	7.3	3.8	7.7

	Germination as Percent †				
Media	Sunflower	Tomato	Bean	Beet	Mean, All Plants
Control -12	56	77	33	67	58
Low -12	72	72	30	87	65
High -12	64	82	57	75	69
Control - 33	78	83	67	73	75
Low - 33	72	77	73	63	71
High - 33	64	73	77	77	73

†Absence of notations following numbers indicates no statistically significant effects were observed.

Table 19. Day-160 Compost Bioassay Germination Results

	Germination per Pot	
Media	Sugarbeet	Onion
Control -12	8.3	8.2
Low -12	7.3	9.7
High -12	6.5 *	8.5
Control - 33	8.7	8.0
Low - 33	6.3 *	8.8
High - 33	7.5	7.7

	Germination Percent		
Media	Sugarbeet	Onion	Mean, All Plants
Control -12	83	82	82
Low -12	73	97	85
High -12	65	85	75
Control - 33	87	80	84
Low - 33	63	88	76
High - 33	75	77	76

* Denotes a significant difference from corresponding control at $p < 0.05$

Table 20. Day-90 Compost Bioassay Results

	Fresh Weight per Plant, mg †					
Media	Sunflower	Tomato	Bean	Petunia	Onion	Beet
Control -12	1048	1137	6492	2118	280	1118
Low -12	1057	1203	5865	2080	263	932
High -12	978	1072	5675	2063	308	1075
Control - 33	1133	1185	5717	2050	278	1000
Low - 33	1173	1242	5192	1970	290	907
High - 33	1133	1200	5625	1972	278	1093

	Fresh Weight per Plant, % of Control †						
Media	Sunflower	Tomato	Bean	Petunia	Onion	Beet	Mean, All Plants
Low -12	101	106	90	98	94	83	95
High -12	93	94	87	97	110	96	96
Low - 33	104	105	91	96	104	91	98
High - 33	100	101	98	96	100	109	101

Note: Plants tops were harvested at the following ages: sunflower, tomato, bean and beet – 24 days; petunia – 35 days; onion – 34 days.

†Absence of notations following numbers indicates no statistically significant effects were observed.

Table 21. Day-123 Compost Bioassay Results

Media	Sunflower	Tomato	Bean	Petunia	Onion	Beet
	Fresh Weight per Plant, mg					
Control -12	639	362	3730	1831	303	1924
Low -12	579	330	4093	1743	322	1843
High -12	556	344	3838	1829	275*	1649
Control - 33	556	300	4626	1640	260	2476
Low - 33	499	276	3978	1469	289	2613
High - 33	765	276	3698	1587	279	2256 ‡

Media	Sunflower	Tomato	Bean	Petunia	Onion	Beet	Mean, All Plants
	Fresh Weight per Plant, % of Control						
Low -12	91	91	110	95	106	96	98
High -12	87	95	103	100	91	86	94
Low - 33	90	92	86	90	111	106	96
High - 33	138	92	80	97	107	91	101

Note: Plants tops were harvested at the following ages: sunflower–19 days; tomato–20 days; bean–18 days; beet and onion–34 days; petunia–35 days.

* Denotes a significant difference from the control at $p \leq 0.05$

‡ Denotes a difference from the control at $p \geq 0.10$. Mean of high-12 and high-33 was significantly lower ($p \leq 0.05$) than controls.

Table 22. Day-160 Compost Bioassay Results

	Fresh Weight per Plant, mg	
Media	Onion	Beet
Control -12	230	1569
Low -12	238	1406
High -12	235	1341 ‡
Control - 33	237	2238
Low - 33	256	1933
High - 33	262	2161

	Fresh Weight per Plant, % of Control		
Media	Onion	Beet	Mean, All Plants
Low -12	103	90	97
High -12	102	85	94
Low - 33	108	86	97
High - 33	111	97	104

Note: Plants tops were harvested 39 days.

‡ Denotes that the level of statistical difference from the control is $p \leq 0.14$

Table 23. ANOVA Report for Sugarbeet Bioassay Plant Weight Results, for All 12% Medium Treatments and All Compost Ages

SOURCE: treat	treat age	N	MEAN	SD
contr		18	100.0	19.3
low		18	89.7	12.1
high		18	89.1	11.7

SOURCE: treat	age age	N	MEAN	SD
	160	18	91.7	12.1
	123	18	93.9	12.8
	90	18	93.2	20.6

SOURCE: treat	treat age age	N	MEAN	SD
contr	160	6	100.0	14.5
contr	123	6	100.0	18.4
contr	90	6	100.0	26.8
low	160	6	89.6	9.9
low	123	6	96.0	5.3
low	90	6	83.4	16.7
high	160	6	85.4	7.3
high	123	6	85.8	8.0
high	90	6	96.2	16.1

SOURCE	SS	df	MS	F	p
treat	1349	2	674	2.788	0.109
tr/	2419	10	242		
age	48	2	24	0.124	0.884
ar/	1931	10	193		
ta	871	4	218	1.118	0.376
tar/	3897	20	195		

Table 24. ANOVA Report for Sugarbeet Bioassay Plant Weight Results, for All 33% Medium Treatments and All Compost Ages

SOURCE:	treat			
treat	age	N	MEAN	SD
contr		18	100.0	17.0
low		18	94.2	17.3
high		18	99.1	19.6

SOURCE:	age			
treat	age	N	MEAN	SD
	160	18	94.3	13.7
	123	18	98.9	12.2
	90	18	100.1	25.2

SOURCE:	treat age			
treat	age	N	MEAN	SD
contr	160	6	100.0	6.8
contr	123	6	100.0	6.5
contr	90	6	100.0	29.8
low	160	6	86.4	17.1
low	123	6	105.5	13.6
low	90	6	90.8	17.4
high	160	6	96.5	13.5
high	123	6	91.2	12.4
high	90	6	109.5	27.5

SOURCE	SS	df	MS	F	p
treat	347	2	173	0.927	0.427
tr/	1872	10	187		
age	337	2	169	0.267	0.771
ar/	6313	10	631		
ta	1931	4	483	2.311	0.093
tar/	4179	20	209		

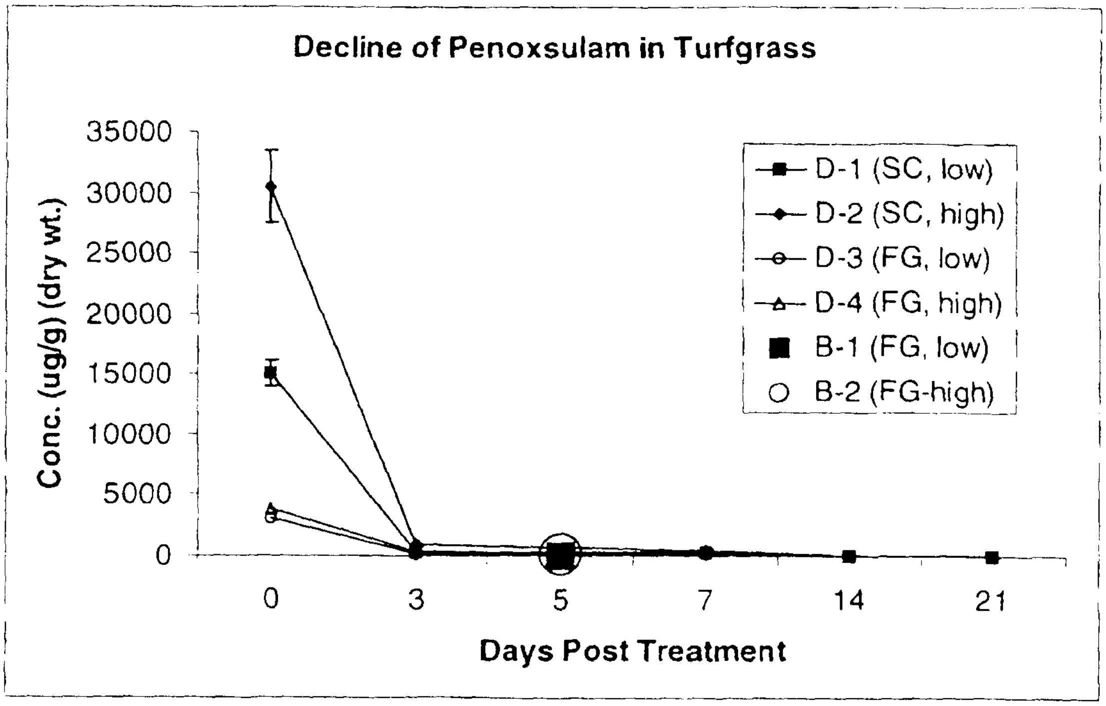
Table 25. ANOVA Report for Onion Bioassay Plant Weight Results, for All 12% Medium Treatments and All Compost Ages

SOURCE:	age			
age	treat	N	MEAN	SD
160		18	101.7	10.8
123		18	99.1	11.7
90		18	101.8	15.2

SOURCE:	treat			
age	treat	N	MEAN	SD
	contr	18	100.1	10.5
	low	18	101.3	12.6
	high	18	101.1	14.9

SOURCE:	age treat			
age	treat	N	MEAN	SD
160	contr	6	100.2	10.0
160	low	6	103.2	10.0
160	high	6	101.7	13.7
123	contr	6	100.0	9.1
123	low	6	106.3	11.7
123	high	6	90.8	10.1
90	contr	6	100.2	13.8
90	low	6	94.5	14.4
90	high	6	110.7	15.1

SOURCE	SS	df	MS	F	P	
age	85	2	43	0.412	0.673	
ar/	1036	10	104			
treat	15	2	7.3889	0.052	0.95	
tr/	1425	10	143			
at	1548	4	387	2.97	0.045	*
atr/	2607	20	130			



	Turfgrass Conc.s Among All Treatments									
	D-1 (SC, low)		D-2 (SC, high)		D-3 (FG, low)		D-4 (FG, high)		B-1 (FG, low)	B-2 (FG, high)
DAT	mean	(sd)	mean	(sd)	mean	(sd)	mean	(sd)		
	(ug/g) (dry wt.)									
0	14974	(1077)	30434	(2970)	3063	(45)	3814	(41)		
3	274	(85)	890	(99)	131	(4)	297	(110)		
5		- -		- -		- -		- -	49.1	143
7	256	(53)	530	(54)	118	(16)	245	(33)		
14	18	(2)	59	(5)	19	(4)	53	(7)		
21	7	(3)	20	(4)	5	(3)	8	(1)		

Figure 2. Decline of Penoxsulam in Turfgrass

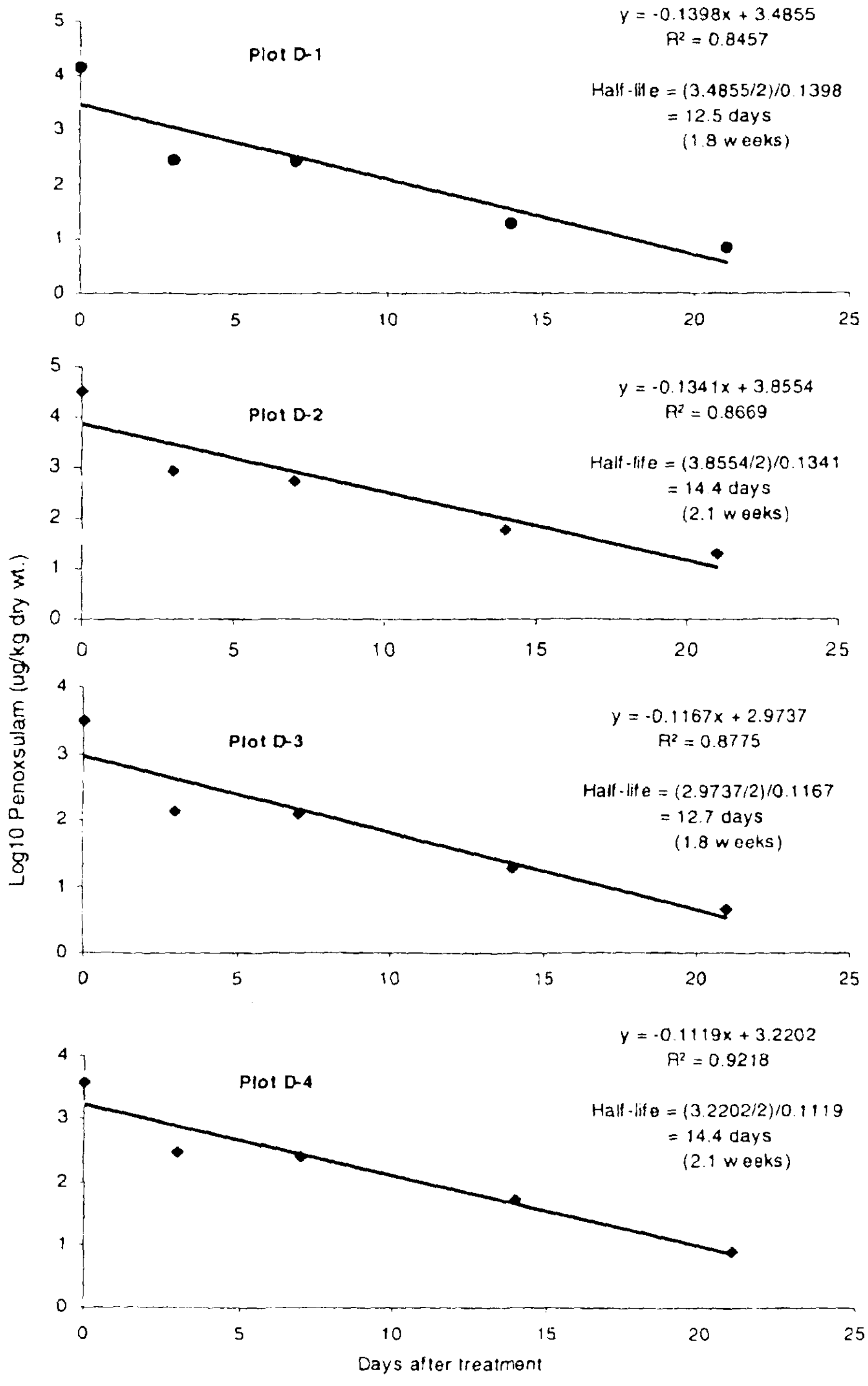
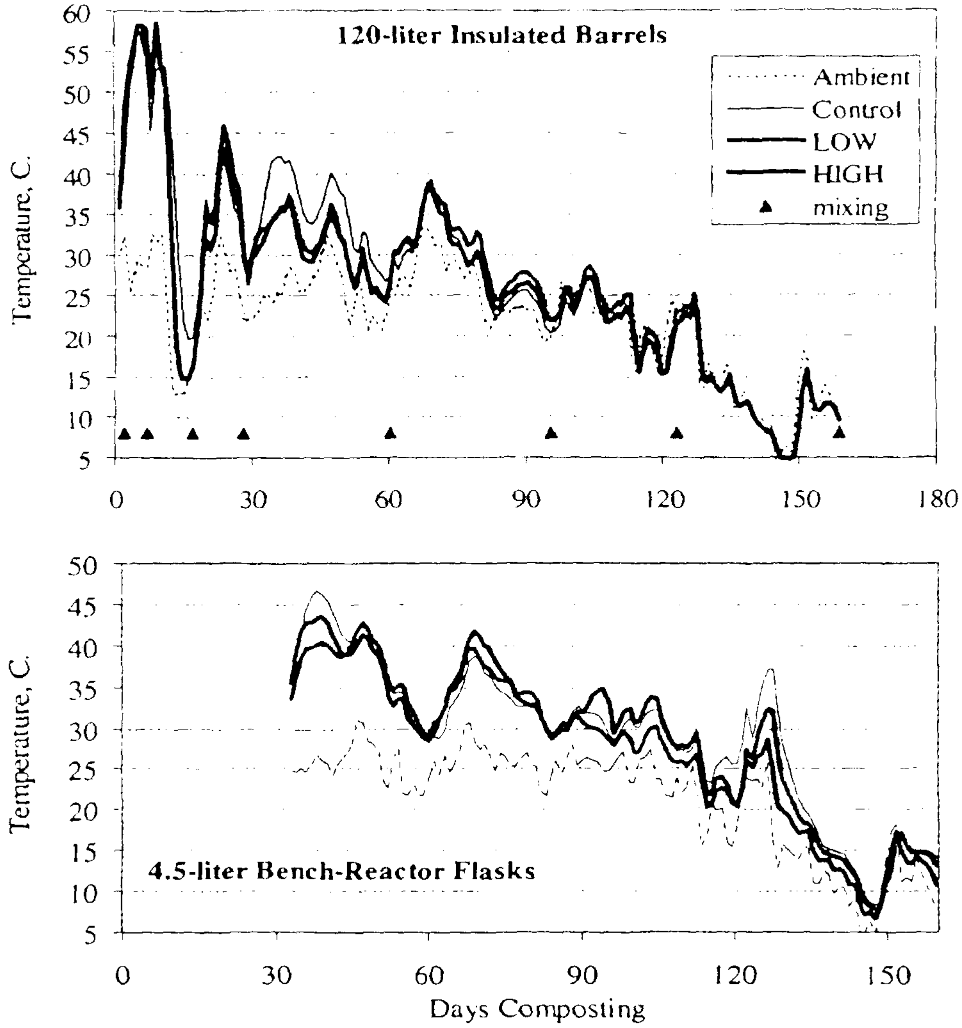
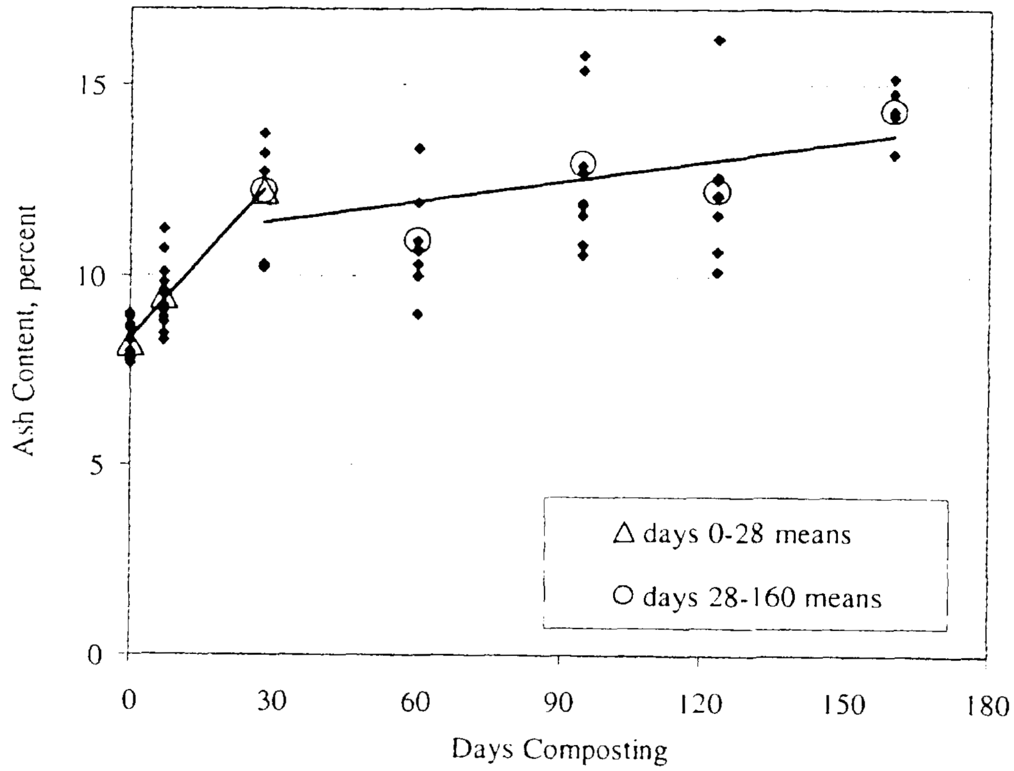


Figure 3. Field Half-life of Penoxsulam in Turfgrass



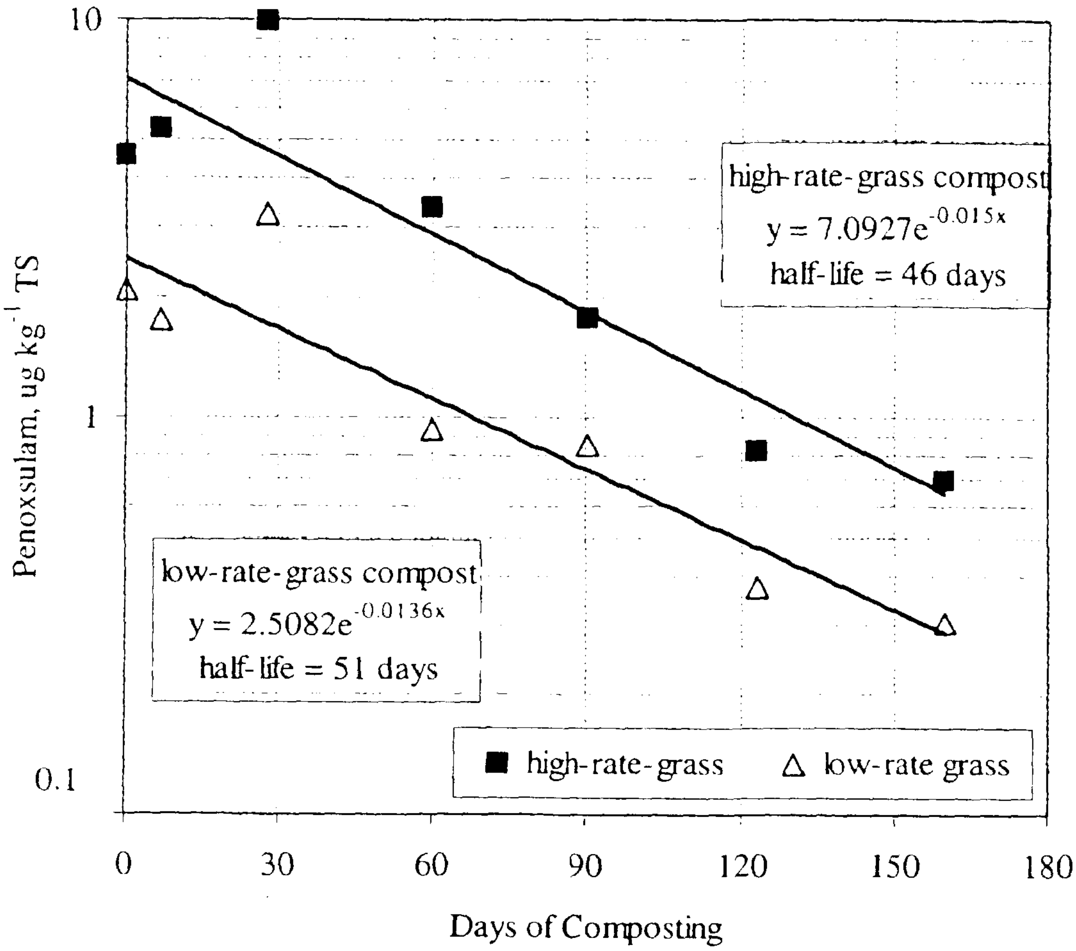
Note: Compost consisted of leaves with grass clippings following HIGH and LOW rate penoxsulam applications as well as control grass without treatment. Composting was started in three 120-liter insulated barrels for each of the three treatments. At day-32 compost was transferred into nine 4.5-liter bench-reactor flasks for each treatment. Contents of all vessels were mixed on days 3 and 17 in addition to the sampling days, 0, 7, 28, 60, 95, 123, and 160. Vessel numbers were reduced as compost volume declined due to decomposition and sample withdrawal.

Figure 4. Self-heating Temperature History of Compost



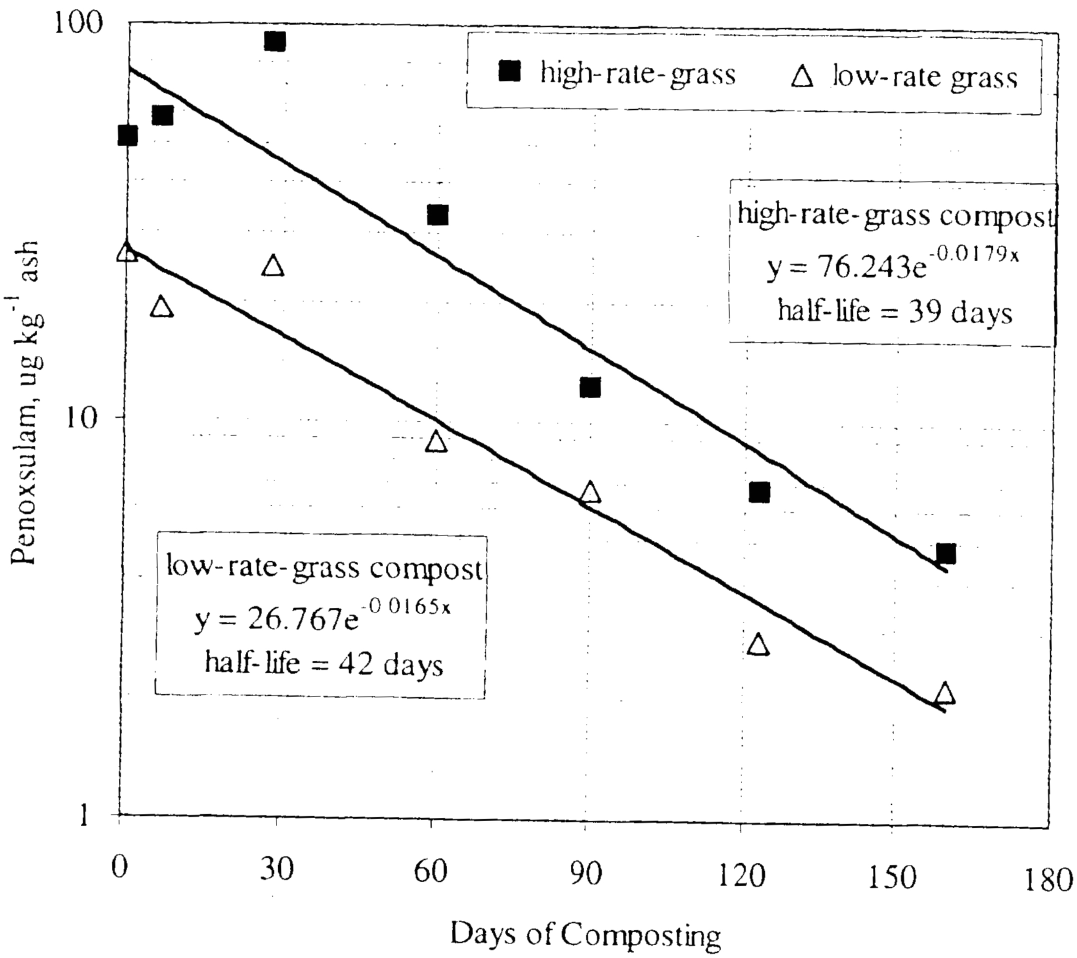
Note: All determinations for control, low, and high compost treatments are shown. Differences among the three compost types were not statistically significant.

Figure 5 . Changes in Ash Content During Composting



Note: Each compost was composted with leaves for 160 days, measured by LC/MS. Each point is the mean of three samples.

Figure 7. Total-Solids-basis Log Plot and Calculated Half-life of Penoxsulam in High-rate-grass and Low-rate-grass Compost



Note: Each compost was composted with leaves for 160 days, measured by GC/MS. Each point is the mean of three samples.

Figure 8. Ash-basis Log Plot and Calculated Half-life of Penoxsulam in High-rate-grass and Low-rate-grass Compost