

# **Sensitivity of Earthworms to Type X Gypsum Drywall Under Controlled Environmental Conditions**

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## **SUMMARY**

This report summarizes the results of a twenty-eight day study that evaluated the sensitivity of earthworms to Type X gypsum drywall. Type X drywall contains less than 1% fiberglass by weight. The study was conducted using two different soil types. These were a Plano silt loam collected from a farm field on the Arlington Agricultural Research Station and an artificial soil composed of a mix of silica sand, kaolinite clay and shredded peat moss. Treatments included a control; the equivalent of 50 lb S/a as commercial gypsum fertilizer; and 500, 1000, 2000, 4000, and 8000 mg/kg crushed drywall mixed with 200 g of either soil. The water content was maintained at field capacity and ten earthworms (*Eisenia fetida andrei* [Bouche]) were added to each jar. The worms were examined weekly to measure weight, number, and activity level. There was no significant effect of any of the treatments on the measured parameters at any of the sampling times. Worm weight decreased in all treatments over the term of the study.

## **OBJECTIVE**

The objective of this study was to examine the sensitivity of earthworms to Type X drywall, following a protocol developed by the US EPA. The study was designed to simulate treatment rates and conditions that would be encountered in agricultural fields during the growing season.

## **PROCEDURE**

Two different types of soil were used for this study. The Arlington soil (Plano silt loam, Typic Argiudoll) was collected from a field on the Arlington Agricultural Research Station near Arlington, WI. This soil is of prairie origin and has been cultivated for over one hundred years in general field crop production. The soil was sieved through a one cm screen to remove stones and crop residue and was then air-dried. The Artificial soil was made in the lab by mixing a ratio of 70% silica sand, 20% kaolinite clay, and 10% peat moss (weight basis). The soil pH of the Arlington and Artificial soil was 5.1 and 5.2, respectively. Finely ground agricultural limestone was added to both soils to reach a target pH of 6.6.

An oven-dried sample of Type X drywall was crushed and passed through a #10 sieve. Screened pieces of fiberglass were returned to the ground material. The paper

covering was removed. Rates to simulate 0, 1000, 2000, 4000, 8000, 16000 lb/a were selected. This resulted in 500, 1000, 2000, 4000, and 8000 mg/kg additions. In addition, control treatments of nothing and 50 lb S/a (294 lb gypsum/a) as commercial gypsum fertilizer were included. All treatments were replicated three times in both soils. Amendments were mixed vigorously with 200 g of the dried soil in one-pint glass canning jars. Three jars for each soil were not treated so that samples could be taken to monitor soil pH and water content during the study. The water content of each soil was adjusted to estimated-field capacity using distilled water and maintained there for the duration of the study. The water content of the two soils was 29.2 % and 18.3 % (weight basis), respectively.

The earthworms, (*Eisenia fetida andrei*, [Bouche]), were supplied NaturTech Composing Systems, Inc. of St. Cloud, MN via Mr. Jim McNelly. The worms were allowed to acclimate for several days prior to their placement into the jars and were fed a small amount of alfalfa pellets prior to the study. No additional food supplements were provided during the twenty-eight day experiment. Ten worms (300-600 mg each) were added to each jar at the beginning of the study.

The study was conducted in a growth chamber at the Biotron on the campus of UW-Madison. The protocol followed that outlined by the USEPA, Office of Prevention, Pesticides, and Toxic Substances (#850.6200). A constant light source with an intensity was 400 lx. Lighting was kept on at all times during the study to encourage the worms to burrow in the soil. Temperature was held constant at 22 degrees C.

The experiment was initiated 20 July 2001, with weekly evaluations over the twenty-eight day period until 17 August 2001. Dates of evaluation were 27 July, and 3, 10, and 17 August. Measurements taken included:

- Total worm fresh weight per jar at each time
- Worm number per jar at each time
- Routine soil tests (pH, organic matter, P and K) at 0 and 28 days
- Worm activity on a 1-5 scale (1=inactive; 5=extremely active)
- Visual evidence of lesions and number of worm cocoons on 17 August

The initial worm weight was determined by selecting ten worms from the lot, washing them gently with distilled water, dabbing them dry with paper toweling, and weighing on a scale sensitive to 1 mg. The worms were not washed prior to recording weights on 27 July and 3 and 10 August because of the concern that excessive handling would affect their survival. They were washed on 17 August at the end of the experiment in a manner similar to that used at the initiation of the study. Worm activity was assessed right after the worms were dumped out of the jar on the examination table.

Data were analyzed with a one-way analysis of variance. A separate analysis was conducted for each soil. The  $Pr > F$  statistic shows the level of significance. A level of 0.10 would be considered significant and would indicate that the same response would be anticipated 90 times if the experiment were conducted 100 times.

## **Results and Discussion**

Table 1 shows the total earthworm weight recorded for each jar at the different measurement times. There was no significant difference at any of the measurement times relative to treatment for either soil. Overall the worms lost substantial weight over the term of the study. These data are shown graphically in Figure 1 (Arlington soil) and Figure 2 (Artificial soil). At first glance the decline in worm weight appears to be much greater in the Arlington soil compared to the Artificial soil, however this observation was likely due to the decision to not wash the worms prior to weighing at the intermediate measurement times. The Arlington soil did not adhere to the worms when removed from the jars for weighing to the extent that the sand grains did in the Artificial soil. Therefore the weights recorded for the Arlington soil are much closer to the true weight of the worms and the weights for the Artificial soil are inflated by the weight of soil particles. Once the soil was washed off at the final weighing the weight of the worms from the Artificial soil decreased dramatically and the weights were similar to those from the Arlington soil. Therefore, the overall weight loss experienced by worms in either soil was similar and was not affected by treatment.

The effect of treatment on the number of worms at each measurement time and their relative activity level is shown in Table 2. Ten worms were placed in each jar at the outset. Treatment did not significantly affect worm survival. There was an anomalous response on 27 July in the Artificial soil where the two high drywall treatments had lower worm numbers. Later measurements showed higher counts. The inconsistency in the worm numbers at the intermediate measurements, especially in the sandy soil, was attributed to the fact that worms were coated with soil and difficult to see. The worm counting procedure was more rigorous on the final date and overall only one worm perished in each soil. The worm activity rating was made at the time the soil was dumped from the jar. It was somewhat subjective because the evaluator had to assess how “wiggly” the worms were at that time as their movement was substantially decreased within a few seconds. The worm activity was not affected by treatment. Overall a decrease in activity was noted in both soils by the end of the study.

A few worms were examined from each treatment with a hand lens for evidence of lesions. There was no evidence of surface abnormalities on any of the worms. No cocoons were found during the study suggesting that the deteriorating condition reduced the reproductive activity of the worms.

The effect of 28 days in the growth chamber on the soil test levels measured in the two soils is shown in Table 3. The soil tested was a composite from jars that did not have earthworms and was tested primarily to monitor pH. Finely ground lime was added to the soils with a goal of increasing the pH to 6.6. This was considered to be optimum for the worms. The formula that was used is written for field soils and appears to have worked well in this situation. It did appear that the P level increased in the Arlington soil and the organic level increased in the Artificial soil. It is not known if these changes would have any effect on the worms. It was not possible to conduct a statistical analysis because only limited samples were collected.

Table 1. Weight of ten earthworms (*Eisenia fetida andrei* [Bouche]) treated with gypsum fertilizer and Type X drywall in a controlled environment.

Treatment*	20 Jul	27 Jul	1 Aug	10 Aug	17 Aug	Change**
----- g -----						
<b><u>Arlington</u>***</b>						
Control	4.86	4.29	3.85	3.11	2.70	-2.16
50 lb S/a	5.75	4.95	4.39	3.82	2.99	-2.76
500 mg/kg	5.48	3.98	3.56	3.09	2.65	-2.82
1000 mg/kg	5.49	4.02	3.86	3.18	2.63	-2.86
2000 mg/kg	5.24	4.17	3.71	3.35	2.79	-2.45
4000 mg/kg	4.91	4.42	3.77	3.15	2.84	-2.07
8000 mg/kg	5.51	4.51	4.02	3.46	2.88	-2.63
Pr> F	0.64	0.75	0.80	0.45	0.79	0.41
<b><u>Artificial</u>***</b>						
Control	5.07	5.92	5.25	4.66	2.48	-2.59
50 lb S/a	4.98	5.45	5.72	5.35	2.69	-2.29
500 mg/kg	4.76	4.43	4.63	4.93	2.46	-2.29
1000 mg/kg	4.96	5.19	4.61	4.76	2.52	-2.44
2000 mg/kg	5.07	6.15	5.38	4.67	2.41	-2.66
4000 mg/kg	5.41	5.76	5.43	5.09	2.46	-2.95
8000 mg/kg	5.48	5.64	5.84	5.18	2.69	-2.78
Pr> F	0.58	0.53	0.26	0.63	0.60	0.29

\* 50 lb S/a is equivalent to 294 lb gypsum fertilizer/a; 500 mg drywall/kg equivalent to 1000 lb drywall/a.

\*\* Difference between initial weight (20 July) and finished weight (17 August).

\*\*\* Arlington soil (Plano silt loam), Artificial soil ( 70% silica sand, 20% kaolinite, 10 % peat).

Table 2. Earthworm number and activity level (*Eisenia fetida andrei* [Bouche]) following treatment with gypsum fertilizer and Type X drywall in a controlled environment.

Treatment*	<u>20 Jul</u>		<u>27 Jul</u>		<u>1 Aug</u>		<u>10 Aug</u>		<u>17 Aug</u>	
	No.	Act**.	No.	Act.	No.	Act.	No.	Act.	No.	Act.
<b><u>Arlington</u>***</b>										
Control	10	5.0	10	5.0	10	5.0	10	5.0	10	4.3
50 lb S/a	10	5.0	10	5.0	10	5.0	10	5.0	10	4.0
500 mg/kg	10	5.0	10	5.0	9.7	5.0	9.7	4.7	9.7	4.0
1000 mg/kg	10	5.0	10	5.0	9.7	5.0	10	5.0	10	4.0
2000 mg/kg	10	5.0	10	5.0	10	5.0	9.7	5.0	10	4.0
4000 mg/kg	10	5.0	10	5.0	10	5.0	10	4.7	10	4.0
8000 mg/kg	10	5.0	10	5.0	10	5.0	10	4.7	10	4.0
Pr> F	--	--	--	--	0.47	--	0.47	0.75	0.61	0.47
<b><u>Artificial</u>***</b>										
Control	10	5.0	10	5.0	9.7	4.0	9.7	3.7	10	4.3
50 lb S/a	10	5.0	10	5.0	10	3.7	10	4.3	10	5.0
500 mg/kg	10	5.0	10	5.0	10	4.7	9.3	4.0	9.7	4.7
1000 mg/kg	10	5.0	10	5.0	9.7	4.0	9.7	4.3	10	4.3
2000 mg/kg	10	5.0	10	5.0	10	4.7	9.7	4.0	10	5.0
4000 mg/kg	10	5.0	8.7	5.0	10	3.7	9.7	4.3	10	5.0
8000 mg/kg	10	5.0	9.3	5.0	10	4.0	10	4.0	10	4.7
Pr> F	--	--	0.02	--	0.61	0.30	0.71	0.53	0.34	0.13

\* 50 lb S/a is equivalent to 294 lb gypsum fertilizer/a, 500 mg drywall/kg equivalent to 1000 lb drywall/a.

\*\* Activity level rating: 1=inactive; 5=extremely active.

\*\*\* Arlington (Plano silt loam), Artificial (70% silica sand, 20% kaolinite, 10 % peat).

Table 3. Initial and final soil test levels for the Arlington and Artificial soils used in the worm activity study.

Soil	Date	pH	Organic Matter %	P ---- ppm ----	K
Arlington	20 Jul	5.1	4.3	27	68
	17 Aug	6.4	4.3	42	79
Artificial	20 Jul	5.2	3.8	15	14
	17 Aug	6.4	5.3	17	14