Using Red Worms as a Model Organism to Test the Effects of Fertilizer Concentrations

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Abstract

The purpose of our experiments were to see whether or not fertilizer had detrimental effects on humans. This is important because, much like carbon monoxide, fertilizer can be a fairly undetectable substance to humans that can cause respiratory issues, allergic reactions, and other irritation and general discomfort. Throughout our examinations of pure concentration reactions and crawling length experiments, we were able to find that red worms did have an adaptive response triggered by the fertilizer. Thus, we can see that fertilizer has the potential to negatively impact humans.

Introduction

Adaptive behaviors are the responses triggered by outside activity or environmental factors. Like many human tissues, worms are easily affected by chemicals, more specifically, fertilizers. Therefore, these responses are extremely valuable in understanding the effects different common chemicals have on humans. Between 40%-60% of inorganic fertilizers are used in the process of growing food. (OSU, 2016) In fact, over 142 tons of fertilizer were used in the year of 2002 (according to the Food and Agriculture Organization). Additionally, many fertilizers (natural or not) have been known to cause a minimum of irritation (eyes and skin), and respiratory tract irritation in humans, and can also cause seizures in animals. (MSDS, 2005) The Miracle Gro Plant Food we used for this experiment contained a lot of urea, known to cause itching, burning, severe allergic reactions, trouble breathing, and other respiratory issues as well. (NCBI, 2016) Thus, we have hypothesized that, when red worms are exposed to a fertilizer concentration of 400 ppm (the recommended concentration for usage) in circle and crawling tests, they will have a severe reaction/adaptive response because there are many unnatural chemicals in the fertilizer.

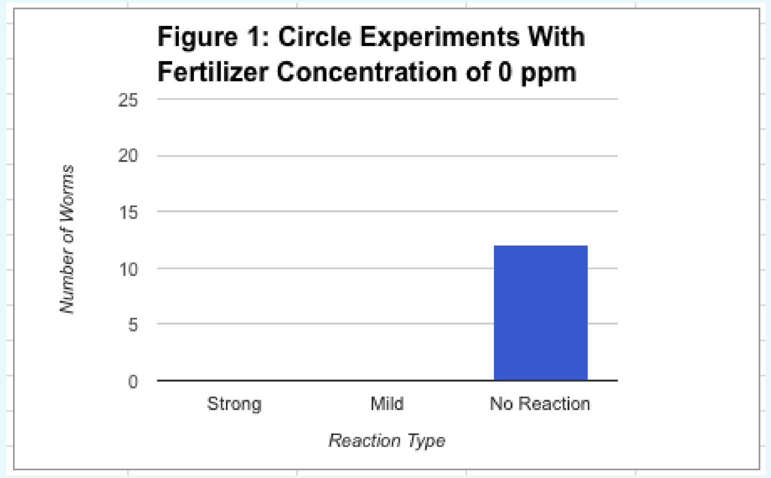


Figure 1: Circle Experiments With Fertilizer Concentration of 0 ppm

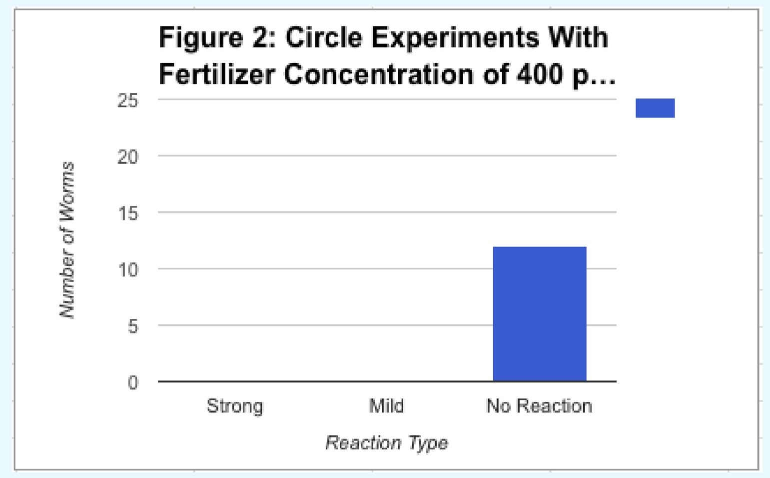


Figure 2: Circle Experiments With Fertilizer Concentration of 400 p...

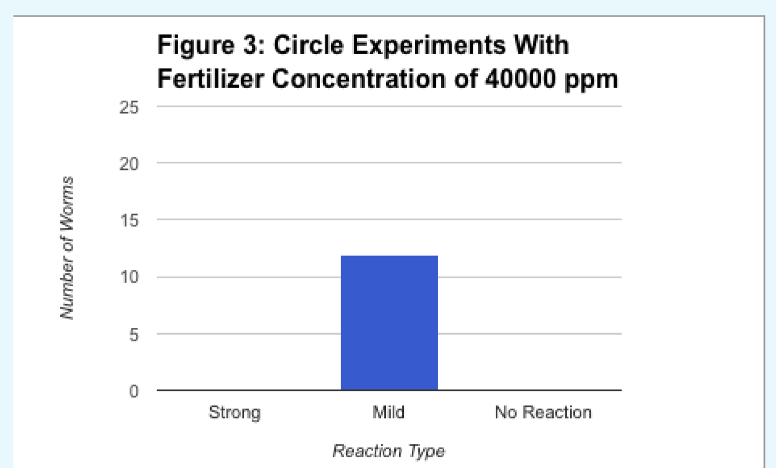


Figure 3: Circle Experiments With Fertilizer Concentration of 40000 ppm

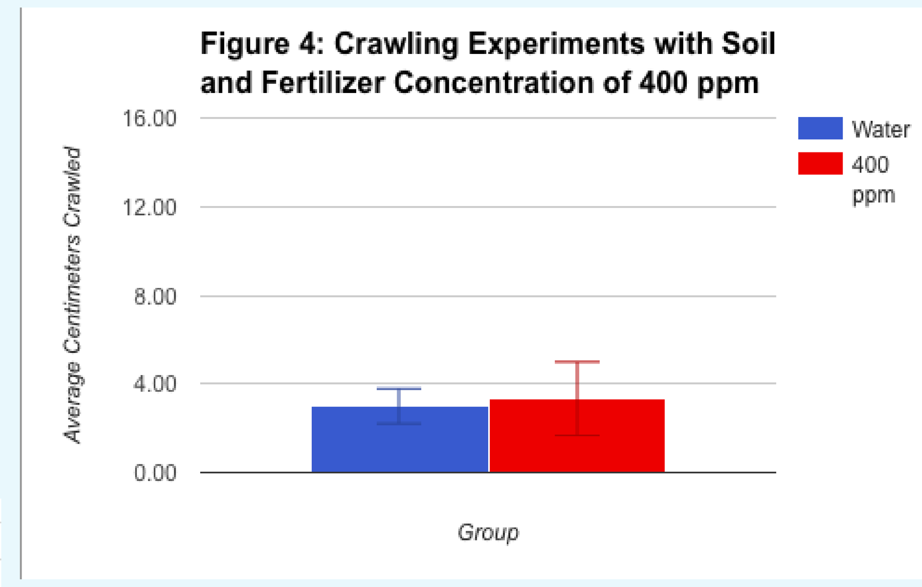


Figure 4: Crawling Experiments with Soil and Fertilizer Concentration of 400 ppm

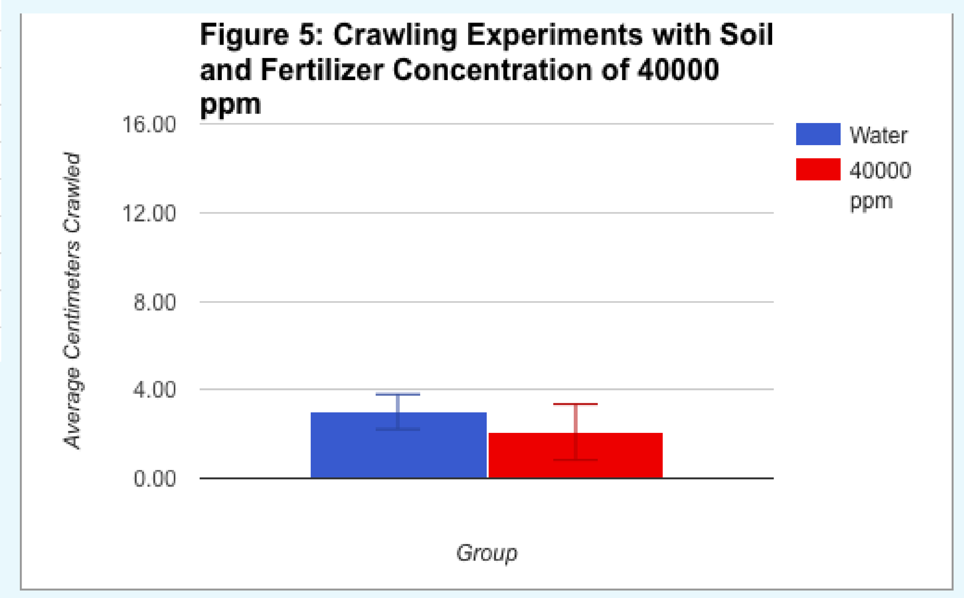


Figure 5: Crawling Experiments with Soil and Fertilizer Concentration of 40000 ppm

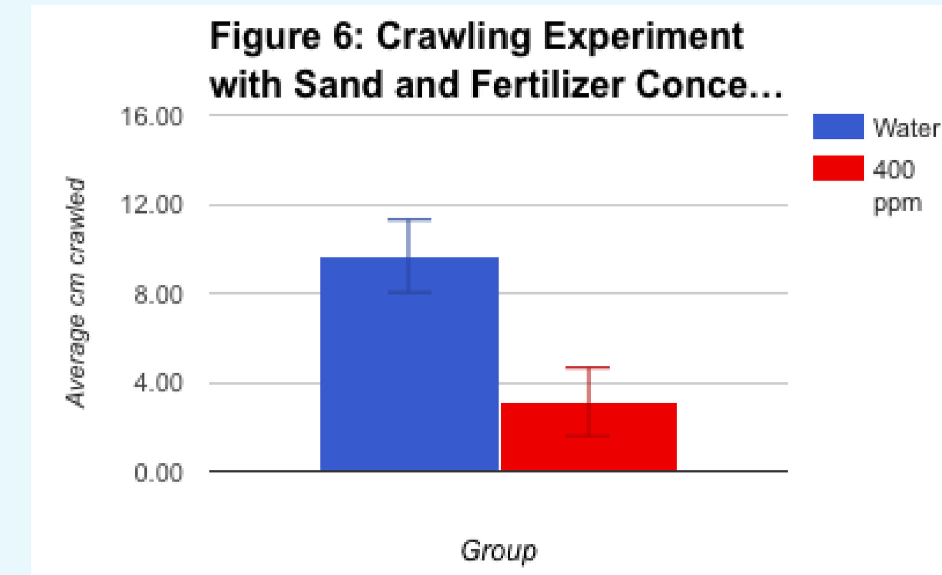


Figure 6: Crawling Experiment with Sand and Fertilizer Conce...

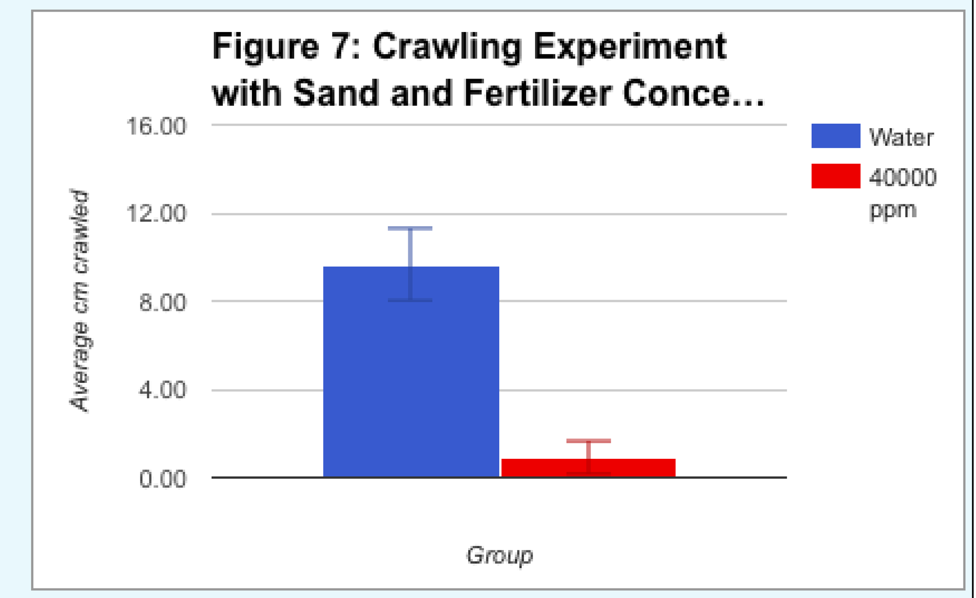


Figure 7: Crawling Experiment with Sand and Fertilizer Conce...

P-Values from T-Tests in Crawling Experiments with Sand and Soil

		Test	
		Crawling with Sand	Crawling with Soil
Concentration	400 ppm	0.00792	0.85836
	40,000 ppm	0.00019	0.57371

Methods and Materials

The circle test is conducted to expose the worms to chemical concentrations in its purest form in order to assess their reactions. For this test, we placed one worm in the middle of a circle made up of droplets of the fertilizer in varying concentrations each time (and water for a control), and then we recorded the reaction of the worm once they were fully immersed in the fertilizer. There are three kinds of reactions: No reaction (no noticeable differences), mild reaction (slowly backing away from chemical), and severe reaction (jerking sensations).

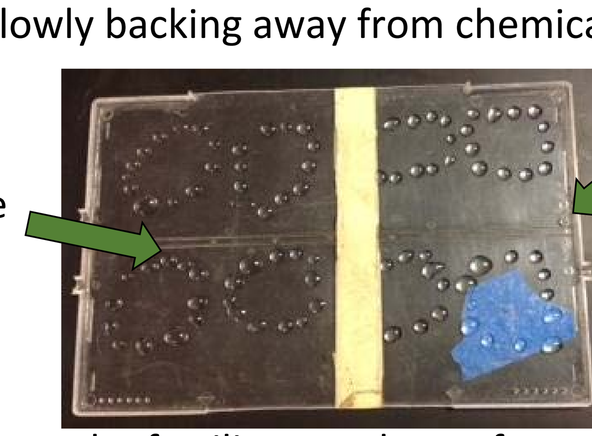
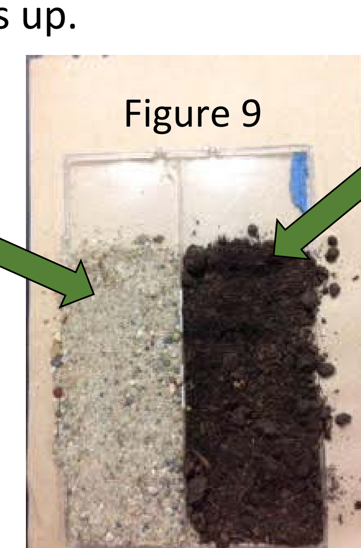


Figure 8

The crawling test is used to determine if the worms have a reaction to the fertilizer on the surface of the soil, similar to how it is in their natural environment. In this test, we soaked sand and soil in varying concentrations of fertilizer and then let the worms crawl along the surface for 15 minutes, recording how far they crawled after the time was up.

Figure 9



We made note of the reactions they had and the distances they crawled by recording them on a Google Spreadsheet that held our data/graphs/charts. We were able to calculate means, medians, standard deviations, standard errors, and p-values from our quantitative data (crawling). The t-test, used to find the p-value, is used to show how significant or different two sets of data are (water/control → fertilizer/variable). If the p-value was less than 0.05, then the sets of data were different, meaning that the values were significant. If the p-value was greater than 0.05, that meant that the sets of data were the same, and rather insignificant.

Results

Our experiment consisted of a circle and crawling test. We did these tests to see how the worms reacted to two different concentrations of fertilizer, 400 ppm and 40,000 ppm. In our experiment, the independent variable was the different concentrations of fertilizer. The dependent variable was the reaction the worms had and the distance they crawled. The role of our control, dechlorinated tap water, was used to compare the effects of fertilizer to normal worm behavior. Our results showed that, the higher the concentration of fertilizer, the more severe the reaction would become. This answered our question of the worms having a reaction to the fertilizer. Also, we had significant p-values (less than 0.05) in tables 6 and 7. This data disproves our null hypothesis because the data for the crawling experiments was different from the control. However we can also accept our alternate hypothesis based on the significant p-values. All of this data shows that higher concentrations of fertilizer can have effects on living organisms, getting more severe after longer periods of exposure.

Works Cited

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Discussion

After conducting our experiments, we accept our alternate hypothesis and reject our null hypothesis. Our alternate hypothesis stated as the fertilizer concentrations are increased, the worm reactions will become more severe because there are many unnatural chemicals in the fertilizer. These chemicals include potassium phosphate, potassium chloride, ammonium sulphate, and urea (MSDS, 2005).

We accepted our alternate hypothesis, because when the worms were fully immersed in the fertilizer at the concentration of 40,000 ppm in the circle test, they showed mild response to the chemical, while no response was shown by the worms in both the 400 ppm concentration and the water control group (Figures 1, 2, and 3). In addition, in the crawling experiments with sand, we found 2 significant p-values (less than 0.05) for the 400 ppm concentration (0.00792), and the 40,000 ppm concentration (0.00019). These significant results indicated a big difference in the distance the worms crawled when in the concentration versus the control (Figures 6 and 7). This data shows that the worms had more severe reactions as the fertilizer concentration increased, resulting in an accepted alternate hypothesis and a rejected null hypothesis.

The p-values were only significant for concentrations in the crawling experiments with sand, not with soil. This agrees with tests previously conducted by other scientists, which convey that soil can absorb more liquid volume than sand, which lessens the chemical effects (NF, 2001). These 2 significant p-values do agree with one another, however, it was unexpected that any test with the 400 ppm fertilizer concentration would produce a p-value less than 0.05, because in the circle test the worms showed no reaction to the chemical at this concentration. It is important to consider the data limitation that we only tested red worms' physical response to fertilizer, not whether or not they can detect it in the environment.

As red worms are a model organism for humans, we can use this data to conclude that it is important to consider the effects of fertilizer on human health, as we had significant results. After conducting these tests, the conclusion can be made that for red worms, no fertilizer at a lower concentration than 40,000 ppm triggers a reaction, and that there can be mild reaction to the fertilizer at this concentration (100 times the usage concentration). Because red worms are a model organism, we can use this data to conclude that it is important to consider the effects of fertilizer on human health, as at the recommended concentration (400 ppm) it does not trigger a noticeable reaction (physical), much like carbon monoxide. Although the red worms had no mild or severe reactions when exposed to the fertilizer at the concentration recommended for usage, if someone was careless and dumped in an amount of fertilizer at random, this would be a concern.