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ARTICLE

Worm pHun

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Worms don't get the respect they deserve! These tiny organisms are the hardest working creatures around, tilling the soil day and night. Despite their usefulness, we usually think of them merely as slimy, wiggly creatures we find as we dig through the garden – if we think of them at all! However, these wiggly, slimy, little creatures are essential for our existence. Without earthworms we could not grow crops in our farms and gardens as there would be no way to break down all of the organic waste on top of the soil. Leaves, dead plants, grass, and weeds would stay in large heaps in farmers' fields. Their job does not end here, though. Did you know that earthworms also provide tunnels deep underground that allow for rainwater to absorb deep into the soil? The worms' passageways also introduce air into the soil, by allowing oxygen and water to percolate down to growing plant roots, and let carbon dioxide produced from the plants flow out into the atmosphere. If all this fertilizing and aerating weren't enough, the earthworms also pitch in to rid the soil of some of the harmful microorganisms that can attack plants and fellow soil dwellers (Science Buddies, 2020). Without these tunnels, we would experience more overland flooding, large run-offs in the spring, not to mention decreased groundwater levels.

As I discovered while preparing this project, earthworms are critical players in the environmental food web found within the soil. Along with bacteria, fungi, other kinds of worms, and insects, the earthworms are part of an intricate web of decomposers that maintain the soil and help each other survive. Earthworms basically eat their way through the soil, and they have a tremendous ability to process the dirt they live in. Some studies suggest that in one acre of topsoil, earthworms consume and mix more than 20 to 40 tonnes of soil per year (Science Buddies, 2020). The worms are also busy eating the plant debris on the surface of the ground as well. The partially digested plant matter is blended back into the soil upon exiting an earthworm's gut, and it increases the soil's levels of essential nutrients including nitrogen, phosphorus, potassium, calcium, and other micronutrients. The excrement deposits are called castings, and they are usually found on the surface of the soil. Thus, earthworms are fertilizer factories for soil and without them, few plants would be able to thrive. The food sources of worms can come from a variety of leftover food or garden items including bits of fruit, chopped vegetables, eggshells, coffee grounds, or plant clippings from your yard. As you have read, their secret underground life is essential to the ecosystem that plants, animals, and humans living above ground all depend on so very much for survival! In this study, I investigate whether the diet of an earthworm affects the pH of the soil.

HYPOTHESIS

For farmers and horticulturalists, it is important to test the pH of the soil since pH influences the availability of essential nutrients. I think that the field waste diet will produce a slightly alkaline (>7 pH) soil, because my research has indicated that most crops will grow satisfactorily in soils with a pH of 6 (slightly acidic) to 7.5 (slightly alkaline) (FAS, 2019).

METHODS

In any experiment, it is important to have controls. These are potential variables that are purposefully kept constant so the results cannot be influenced by them. In the experiment that I performed, the controlled variables included the amount of worms in each container, the type of worm, the size of the plastic tubs, temperature, humidity, the amount of dirt in each tub, the frequency of feedings, the amount of food, and when the pH was measured. The manipulated variable in my experiment was the diet of the worms. The responding variable in my experiment was the pH of the soil.

In order to actually start this experiment, I had to make a trip and visit Roxanne Doerksen, owner of T.R.A.D. Industries. We dug through large bins with our hands and found 500 g of red wiggler worms (see Figure 1). I then created habitats out of shoe box-sized plastic tubs for the worms. I labeled these habitats based on the food I was to add to them: no food (control), starch diet, vegetarian diet, fruit diet, and field waste diet. The field waste was taken from a dryland field in Southeastern Alberta that grew brigade durum wheat in the late fall of 2019.

I used a Kugen Precision 500/0.01 g scale to weigh 250 g of soil into each of the six containers. The soil was extremely dry, so I added some water to just dampen the soil. I also weighed 100 g of worms for each container. In order to evenly distribute them throughout their new living habitat, I gently stirred the worms into the dirt. I did not put worms into the control bin, because I did not add any food to the control bin. In order to keep a moist environment for the worms, I cut some pieces of newspaper and cardboard and lightly wet them with water. I placed a sheet of news-

paper and cardboard over each container. It was very important to store the worms in a cool, damp spot; I chose my garage. Each day, I checked the thermometer and humidity gauge in the garage to ensure that all of the living habitats were experiencing similar conditions. I kept the temperature at 18 °C.

Each Sunday, using the scale, I measured/weighed 5 g of each of the specified diets into the categorized bins. Using a Luster Leaf Rapid Test digital soil pH metre, I recorded the pH of each container. Once finished, I set the newspaper back on top of the worm farm and checked the worms every other day to make sure they had a comfortable living space. I continued this once a week, for six weeks.

Figure 1: Photograph of visit to T. R. A. D. industries to collect worms.

RESULTS

The average pH values were all alkaline. The highest average pH, belonging to the starch group, was 0.43 higher than the lowest average pH, belonging to the control group. The average pH values in ascending order were 7.0 (control), 7.25 (vegetable), 7.32 (fruit), 7.37 (field waste), and 7.43 (starch).

DISCUSSION

In the end, all the diets resulted in appropriate pH values, but you may ask yourself why. The best pH for crops and worms is more of an alkaline pH, and that is what the field waste showed. As you see in Table 1, the starch category (7.43) is only 0.06 higher than the field waste category (7.37). This may be because some of the starches that I fed my worms (e.g., cereals) have calcium carbonate in them, which is known to increase the pH of soil (Uncle Jim, 2016). The vegetable category has a substantial drop compared to the other categories. I think that this might be because we buy most of our vegetables from the grocery store and they come nicely packaged, but that might not be a good thing for the pH of the soil because processed and packaged foods have an additive that is called aluminum sulphate in them that lowers the pH of the soil (Uncle Jim, 2016). It may also be the case with the fruit because we also buy most of our fruit from the grocery store, but the fruit (7.32) only had a minimal drop of 0.05 from the field waste (7.37), so we may have included some more fruit that we had grown at home during the time of the experiment.

EXTENSIONS

If I was to do this experiment again, I would expand my soil analysis. I would find a way to test for nutrients such as the potassium, nitrogen, and perhaps phosphorus in each worm farm. The levels of these nutrients are very important to farmers as they allow them

Table 1: pH Test Results for Each Week of the Testing Phase

	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Average
Vegetable	7.0	7.0	7.4	7.4	7.3	7.4	7.25
Fruit	7.0	7.0	7.3	7.6	7.6	7.4	7.32
Field Waste	7.0	7.0	7.8	7.5	7.5	7.4	7.37
Starch	7.0	7.0	7.5	7.8	7.7	7.6	7.43
Control	7.0	7.0	7.0	7.0	7.0	7.0	7.0

to ensure there are appropriate nutrients in the soil for their crops. My dad does multiple soil analyses every year in order to determine the appropriate fertilizer blend for the particular crop he is going to put in that field. Perhaps this experiment could help him with his crop rotation.

SOURCES OF ERROR

I did this experiment over the winter and stored my worm farms in the garage. I chose this location as it was a dark, undisturbed environment of which earthworms need to thrive, but it may have been a bit too cold at times when the weather changed outside. It is sometimes difficult to regulate the temperature in the garage when the wind is blowing and the weather outside is extremely cold.

CONCLUSION

In the end, all the diets resulted in appropriate pH values. My hypothesis, that the field waste diet would produce a slightly alkaline (>7 pH) soil which is good for crop production (FAS, 2019), was proven correct. The soil from the field waste and starch diets had more alkaline average pH values. This did not surprise me as, according to my research, worms prefer this type of environment. They thrive on a great deal of organic waste and, in turn, produce soil that is viable for producing great dryland crops.

ACKNOWLEDGMENTS

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ABOUT THE AUTHOR - VICTORIA ROOKS

I am a normal teenage girl living on a farm in Southeastern Alberta. Science has been part of my life for as long as I can remember. Days, evenings, and weekends would be spent with my mother doing some kind of amazing science activity! It was natural, then, to start doing my own science fair projects when I was only eight years old. I do not know exactly where my passion lies, as I have done a range of projects from creating UV beads, to seeing if a cell phone is dirtier than a toilet seat (it was!). As I get older, I am finding I have greater interest in biology and chemistry. I aspire to be a radiologist or ER doctor one day. In my spare time, I play tennis, volleyball, basketball, and go dirt biking with my friends. One of my favourite things is my Pomeranian, Buddy!