The Influence of Earthworms on Plant Growth

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Abstract

While visually identifiable by most children and adults, earthworms are less known for their key role in soil ecosystems. As decomposers, earthworms are responsible for modifying physical, chemical, and biological properties of soil and their presence often results in benefits to the local biota. This study investigated how earthworms influence plant growth with a group of local fifth grade students. It was hypothesized that if earthworms benefit the soil by improving soil structure and increasing nutrient availability, then plants grown in the presence of earthworm casting will grow better than those grown without earthworm casting. Each student planted zinnia seeds in two different soil types: potting soil mixed with earthworm casting, and plain potting soil. Unfortunately, unknown and uncontrollable circumstances resulted in damage to the growing plants and subsequent growth ceased. While quantitative data was not able to be collected, the study provided a unique opportunity for students to be exposed to true scientific processes and provided the lesson that experiments do not always work as planned. Experimental design errors were discussed with students and the study will be repeated.

Introduction

If you were to ask a young child what an earthworm is good for, perhaps one of his or her first responses might be, “fish bait!” While that answer is certainly correct, earthworms serve a crucial role in the environment that is often overlooked. Earthworms are one of nature’s top soil scientists; sometimes known as “ecosystem engineers”, earthworms can significantly modify the physical, chemical, and biological properties of soil (Blouin, et al., 2013). These modifications are often responsible for allowing healthy plants to grown which in turn provides us with food.

Earthworms literally eat their way through the earth. As they eat, they indirectly influence (and benefit) the soil ecosystem in a number of ways, including:

- Recycling organic material: along with bacteria and fungi, earthworms are decomposers and aid in processing dung and plant litter.
- Increasing nutrient availability: certain nutrients become more readily available to plants after worm digestion and excretion.
- Improving soil structure: earthworm burrows provide aeration and allow water infiltration.
- Providing food for predators: like all creatures, earthworms are part of food webs. Birds are well known predators, but native earthworms are also food for endangered and endemic land snails.

(Edwards, 1998; Edwards & Bohlen, 1996)

Direct exposure with living things can increase a student’s understanding of biological processes. Earthworms are ideal animals for this type of exploration as they are easily accessible and children have usually come into contact with them through previous personal exploration at some point in their lives.

To help demonstrate the role of earthworms in the environment, a guided inquiry was completed with a local fifth grade classroom. The objective of this study was to determine if plants in casting enriched soil grow better than plants grown in soil without castings? Better growth, as defined by the students, was to be assessed by plant height and the number of true leaves on the plant. It was hypothesized that if earthworms benefit the soil by improving soil structure and increasing nutrient availability, then plants grown in the presence of earthworm casting will grow better than those grown without earthworm casting.

Methods

Lesson Development and Execution

The lesson used to carry out this experiment was taught in a fifth-grade classroom at Cline Elementary in Centerville, OH. The class was comprised of 23 students, 12 male and 11 female, ranging in age from 10 to 11 years old. Students had completed an introductory unit on decomposers and their role in the ecosystem with their instructor one week prior. This unit included reading *Wiggling Worms at Work,* by Wendy Pfeffer as well as a brainstorming session, ‘Worm Wonderings’, in which the students posed additional questions about earthworms’ roles in the ecosystem. The follow-up lesson led by the author aligned with Next Generation Science Standards for grade five life sciences (5-LS2-1.A and 5-LS2-1.B) and included a hands-on exploration period in which students examined their own worm with hand lenses and other available tools. Anatomy was loosely discussed and the role of earthworms in the environment was revisited.

Digging Deeper with an Ongoing Experiment

To help demonstrate the potential soil benefits yielded by earthworms, an ongoing experiment was prepared and carried out by the class. All students obtained and appropriately label two peat pots (name, with castings / name, without castings). To one peat pot, students added ¾ cups top soil and planted 5 zinnia seeds ¼" deep. To another peat pot, students added ¾ cups top soil enriched with earthworm casting* and planted 5 zinnia seeds ¼" deep. Students then added tap water to both peat pots to moisten soil. Peat pots were placed uniformly within the classroom greenhouse and left undisturbed. Growing plants were then monitored over the course of 7 weeks; students watered plants as necessary to keep soil visible moist, but not 'soggy'.

*Top soil enriched with earthworm casting was comprised of 3 parts topsoil for every 1 part casting (per product instruction).

Data Collection and Interpretation

Plant heights were measured once a week, beginning after germination. The number of leaves per plant were also noted by students. Results were tabulated and growth progress was examined using both bar and line graphs to compare samples.

Results

While germination times were not recorded by students, it was observed that neither plant samples with earthworm casting nor those without displayed a clear advantage in germination time. In some cases, students observed plants planted in soil with casting germinating earlier and in others, the opposite was observed. Some students did not produce sprouts in either sample set. Data collection was stopped in entirety after 4 weeks due to unforeseen sample loss. Neither sample set displayed enough growth to use leaf count to assess growth success.

Discussion

The indirect influence of earthworms on an ecosystem was examined by conducting observations on plant growth in a controlled system with a class of local fifth grade students. Unfortunately, unknown and uncontrollable circumstances resulted in damage to the growing plants' cotyledons and subsequent growth ceased.

Data collected by students over the course of 4 weeks did not provide conclusive evidence on the influence of earthworm casting in soil, however, literature supports the students' prediction, that plants grown in the presence of earthworm casting would grow better (as previously defined) than those grown without casting. Previous investigations have demonstrated consistently that vermicompost organic wastes can have beneficial effects on plants grown in greenhouse container media or natural field amendments (Arancon, Lee, Edwards, & Atiyeh, 2003; Atiyeh, Lee, Edwards, Arancon, & Metzger, 2002). A review of 67 studies shows that the majority of the time (79%), the presence of earthworms indicates increased plant biomass. It was noted by the author, however, that completed research could be biased as most plants investigated are agricultural (Scheu, 2003). This bias is most likely present due to the implicated ecosystem services earthworms provide to the agriculture industry (Blouin et al., 2013). Though less often, increased plant biomass has also been documented in greenhouse ornamental plants, such as marigolds (Arancon et al., 2003). Root growth, number of fruits, leaf area, plant heights, and above ground dry matter weights increased considerably in plants containing vermicompost's humic acid (Arancon et al., 2003).

Several ideas have been proposed as to what caused the loss of samples, it should be noted, however, that such propositions are speculations and that damaged plants were not seen by the author before being discarded. The classroom teacher described the plants as looking "eaten"—that one morning the leaves were "gone". Insect damage was speculated, however, it should be noted that online gardening guides indicate zinnias are not overly susceptible to insect damage (bachmans.com; burpee.com). As other growing plants in the greenhouse were not damaged, insects seem unlikely to the author. A more plausible explanation is that the zinnia plants were overwatered by students. These plants are susceptible to mildew and bacterial blight, and it is possible that watering protocols were not properly conveyed and that proper soil aeration was not achieved.

While quantitative experimental data could not be assessed, the students participating in this experiment were unique given exposure into the true scientific process. Often, experiments do not succeed; professional scientists spend months, even years, trying to answer a particular question. What should be encouraged more within classrooms, however, is that the *process of doing* science is just as, if not more important, than the content covered. While facts are important, children need to begin to build an understanding of basic concepts and how they connect and apply to world in which they live.

The experimental "failure" created a unique opportunity to re-enter the classroom and discuss what we were still able to learn from our study with the students as well as to note flaws in our experimental design. The classroom teacher is planning to repeat this experiment before the end of the school year with hopes of producing more conclusive results. Some experimental design changes have been proposed by the students so far:

- Use different seeds for potential increase in germination success.
- Reduce the amount of water delivered to each plant and/or delivery system.
- Establish system for identifying different sprouts in the same container to ensure consistency in measurements over multiple weeks.

- Place plants more uniformly within the greenhouse.
- Obtain additional measurements on plants to assess growth including root structure and leaf color.

Literature Cited

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