The Effect of Worms on Plant Growth

Botany

Experimental Investigation

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Signature of Sponsoring Teacher

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PURPOSE

The purpose of my science fair project is to find out if the presence of earthworms in the soil makes plants grow better. Additionally, I want to improve upon my first experiment to see if it yields different results. This was tested by growing three different varieties of seeds in planters containing 12 oz. of soil, ½ of them with earthworms and ½ without. The control group is the planters without earthworms.

HYPOTHESIS

When earthworms are present in the soil of plants, I believe plants will grow better because earthworms digest soil and organic matter which is returned to the soil as “castings” which are rich in nutrients and beneficial for plant growth.

REVIEW OF LITERATURE

What is the best way to help plants grow better? Does the presence of earthworms in soil affect the growth of plants? In order to answer these questions, one must explore how plants are cultivated and grown. Also some of the contributing factors that influence plant growth must be researched. These contributing factors consist of: the study of agriculture and the physical properties of soil, plants, and earthworms. Additional items to be considered are the science behind plant germination and photosynthesis.

Agriculture is one of the oldest industries in the world. Agriculture refers to the cultivation of plants and animals for the benefit of humans. Agriculture began in the Middle East about 10,000 years ago. Middle Eastern countries were the first to grow plants from seeds. Before the industry of agriculture was developed, people had to gather wild plants for food along with hunting and fishing. Because they were continuously searching for food, they had very little time for other activities. Due to the fact that our global population keeps growing, society needs to realize the importance of agriculture in their daily lives. The United States is a leading provider of food to our country as well as others. In order to maximize the amount of people that can be fed through farming and agriculture, it is important to continuously look for ways to produce the largest quantity, and best quality, products. In order to increase agriculture, more research needs to be done to find improvements that can be made to ensure the demands for supply can be met. These facts led me to research possible ways to improve plant and seed growth. Some research I identified indicated that earthworms can improve plant growth when present in soil.

Soil is a very important ingredient for life on Earth. Soil is a thin layer of material that covers most land on Earth. Soil is made up of pieces of humus (dead animal and plant material) and rock that have broken down and combined with Earth's surface to form dirt. Humus also contains many nutrients that help plants to grow. Soil can range in depth from one inch to several feet deep. There are over 70,000 different soil types that have been identified in the United States. Soil's basic composition consists of minerals, water, air and organic matter. It is classified by its structure, texture, living organisms and acidity. Soil also contains sand, salt or clay. The minerals and nutrients found in soil include nitrogen, phosphorus, and potassium. Nitrogen helps plants grow leaves. Phosphorus helps plants grow seeds and flowers. Potassium helps to protect plants from disease. Additionally, both phosphorus and potassium help plants grow strong roots. As you can see, the composition of soil is complex, with many vital components coming together to provide a nurturing environment for growth. Farmers depend on soil to grow crops and plants depend on soil to grow.

"Plants are the key to life on Earth". (Burnie, 2003). There are over 260,000 different kinds of plants present on earth. Plants consist of four main parts: roots, stem, leaves and flowers. The roots take in water and minerals, the stem supports the leaves and flowers, the leaves make food for the plants and the flowers hold the seeds. Plants begin to grow when seeds begin to sprout. When seeds take in water, they begin to swell. As the seed continues to swell, it eventually splits open to reveal a seedling. The lower part of the seedling is in the ground and turns into a root. The roots of the plant hold the seedling in place. More roots grow off of the main root. The seedling then begins to grow upward out of the ground. The top of the seedling is called the bud and the plant's first leaves grow from there. When the leaves of the plant take in sunlight and produce food for the plant, it is called photosynthesis. Photosynthesis occurs

when plants make food by using light from the sun, taking water and minerals from the soil and a gas called carbon dioxide from the air. During the food making process, plants release oxygen into the air. If plants were not present on Earth, people and other living things would not be able to survive. Many life forms depend on things that plants provide in order to survive.

Earthworms are a type of segmented worm that live in the soil. They are cylinder-shaped, slender creatures. There are over 3,000 species of earthworms all over the world. Each segment of a worm has tiny, stiff hairs and is covered with a mucous substance to help make it easier for them to move through soil. These tiny hairs and slimy texture also act as a defense mechanism against predators, the hairs hold it in its burrow and make it hard to be pulled out and the mucous makes them slippery and hard to hold onto. Earthworms have no eyes or nose, just a mouth at one end of their body. Earthworms possess the senses of touch and taste, and are able to detect light and feel vibrations. Earthworms live anywhere with moist soil and dead plant material. Earthworms eat and live off of dead plant material such as leaves, tiny roots and dead or decaying grass. Earthworms have been said to be responsible for helping make our soil better for growing healthy plants and food.

When worms are present in the soil, the organic matter present in the soil (leaves, grass and tiny roots) are eaten and broken down by earthworms and made into nutrients that plants live on. After earthworms eat organic matter, they leave behind their waste, also called castings, which in turn, fertilize the plants growing in the soil. These castings are brought to the surface by the earthworm, therefore turning over the soil. This constant turning over of soil keeps it fertile and provides optimal conditions for plant growth. As the worms burrow through the soil, they also create tunnels that help absorb water, serve as drainage systems, and help circulate air

through the soil. These tunnels help to make loose soil which is easily penetrated by the roots of growing plants.

Worms do best in soil with moderate moisture. Too much or not enough moisture can lead to soil that is too compacted or too dry and not suitable for the earthworms or the plants. Earthworms have also been known to damage the seedlings of some plants while burrowing in the soil, therefore making them hard or impossible to grow.

Does the presence of earthworms in the soil of plants affect plant growth? Earthworms burrow through dirt digesting soil and organic matter which is returned to the soil as castings which are rich in nutrients and beneficial for plant growth. It has been estimated that there can be as many as three million earthworms in one acre of soil. With this many worms working together, essential nutrients are constantly being released into the land. "Without their continual action in aerating and draining, pulling down leaves and throwing up worm casts, the earth, or at least uncultivated land would become far less suitable for plant growth."(Burton, 2002). These findings could help farmers grow quality crops that could help fill the needs of our global society and improve agricultural practices. For more information on earthworms and how they affect plant growth please visit the following website: www.urbantextillinois.edu/worms/live/index.cfm.

A critical piece of research that contributed to my study of plant growth was an experiment I conducted last year. The experiment was a first attempt to study the effects of earthworms on plant growth. While available scientific research noted above suggests that the presence of earthworms in soil positively contributes to better plant growth, the initial experiment did not yield those same results. In reviewing the research, and the results of the

experiment, additional questions were raised regarding points that may not have been considered. One question that immediately came to mind was 'what process actually occurs to make a seed sprout into a plant?' Additionally, one can question the use of an artificial light source in the experiment, wondering if this negatively impacted the results by depriving the seeds of any components needed for healthy growth. These questions led to further research on the specifics of seed germination and photosynthesis.

In addition to the physical properties of soil, plants, and earthworms, the details of seed germination must also be considered. A seed is a tiny 'life-support package'. Inside a seed is an embryo consisting of the basic parts from which a seedling will develop, along with a supply of food. The food is needed to keep the embryo alive and to fuel the process of germination (growth). Germination is the name for the moment when seeds start to grow into plants. The amount of time it takes for seeds to germinate varies depending on the type of seed. When a seed germinates, it grows in 2 directions - upward and downward. The part that grows upward out of the soil is called the 'shoot', and the part that grows downward deeper into the soil is called the 'root'. Seeds will not germinate until they have 3 critical elements working together: water, warmth, and oxygen. These elements must be present all at the same time, and in the correct amounts. This explains why seeds purchased in packets at the store do not sprout 'on their own'; the 3 critical elements necessary for germination are not present in the seed packet. During germination, the seed absorbs water, the cells of the embryo start to divide, and eventually the seed case (also called a 'testa') breaks open. First, the beginning of the root system (also called the 'radicle') sprouts and grows downward. Quickly after that, the shoot (also called a 'plumule') will sprout and grow upward, producing the stem and leaves of the plant.

Finally, when looking into what makes plants grow, and how to make them grow better, it is important to understand the science behind photosynthesis. Photosynthesis is the process in which green plants make their own food, which is essential to their continued growth. While photosynthesis is mentioned briefly earlier in the paper, further research was conducted after reviewing the results of the first experiment. As previously noted, a concern was raised regarding the use of artificial light in the previous experiment and whether or not this may have influenced the results. This warranted additional research to better understand the potential benefits to be gained from using natural light. Plants use light from the sun, carbon dioxide (gas) from the air, and water from the soil to generate food. Using energy also received from the sun, plants combine the sunlight, carbon dioxide, and water to make sugars which they then use for food. These 'sugars' (formally named glucose) turn into starch which is stored in the cells of the plant leaves until they are needed by the plant for food. As you can see, plants do not need to 'find' food because they can make it for themselves using the light and energy gained from the sun in combination with carbon dioxide and water.

One additional component in a plant's production of food that has not yet been mentioned is chlorophyll. Chlorophyll is the green pigment found in plants that gives them their characteristic green color. It is also used in the process of converting energy from the sun into chemical energy stored in the form of starch. My research identified that the process of photosynthesis is most effective with natural sunlight, though it is also possible to cultivate and grow plants using artificial light sources. Any object that gives off light we can see is referred to as a 'light source'. Natural light sources are sources of light that are not created by people, they occur 'naturally'. The most notable example of a natural light source is the sun. Artificial light sources are ones that don't occur naturally, they are created. Electric lights, oil lamps, and even

candles are examples of artificial light sources. Both natural and artificial light sources provide us with the same primary benefit – light, which allows us to see. Both natural and artificial light sources also provide heat. However, natural light sources, particularly the sun, provide added benefits such as helping the body to produce vitamin D, which helps to build strong bones and teeth. Natural light provides similar added benefits to plants and their healthy development.

PROCEDURE

1. Take 6 (16oz.) planters and label them as follows: cilantro with worms, cilantro without worms, radishes with worms, radishes without worms, carrots with worms, carrots without worms.

2. Fill each planter with 8 oz. of soil.

3. Add 5 seeds to each planter matching the labels (cilantro, radishes and carrots).

4. Add 3 worms to the planters labeled “with worms”.

5. Top each of the planters with 4 additional ounces of soil.

6. Place all 6 planters in a location that receives natural sunlight.

7. Add one tablespoon of water to each planter daily.

8. Measure and record the growth of each plant using a centimeter ruler daily for 21 days.

MATERIALS

(6) 16 oz. planters

72 oz. of soil (12oz. per planter)

9 earthworms

10 cilantro seeds

10 radish seeds

10 carrot seeds

Paper to label cups

Sticky notes to record elapsed days

Marker

1 tbsp. measuring spoon

1 ruler

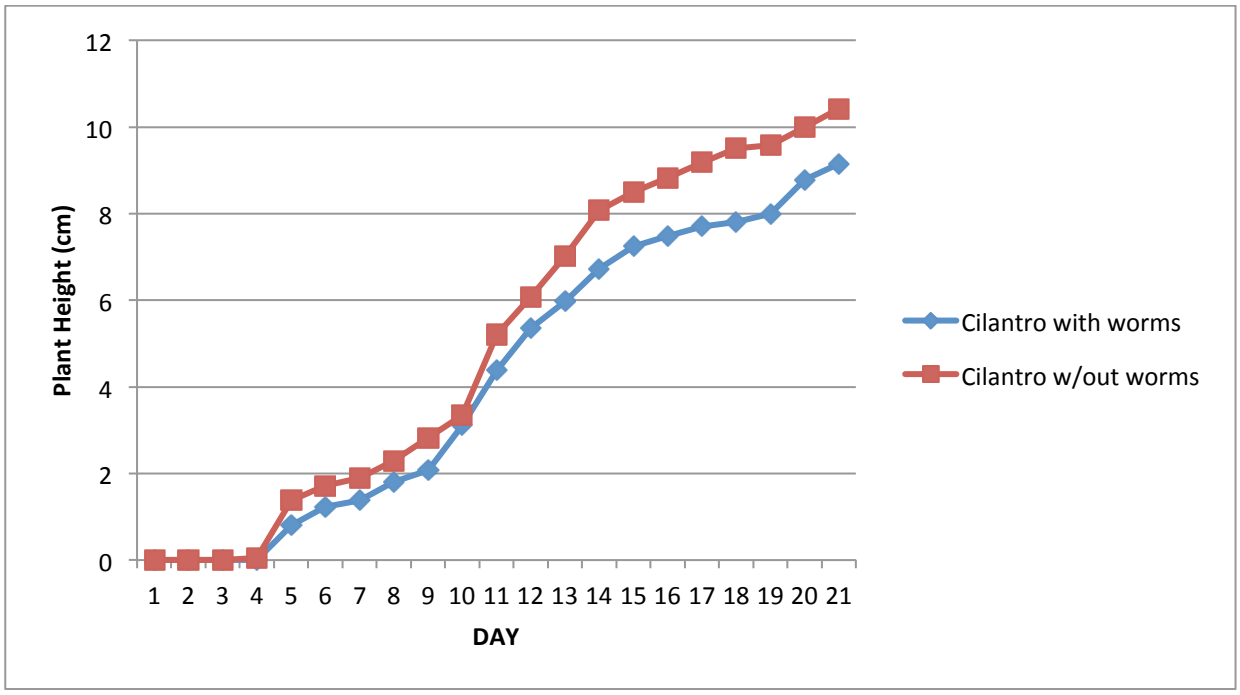
Plain water (room temperature)

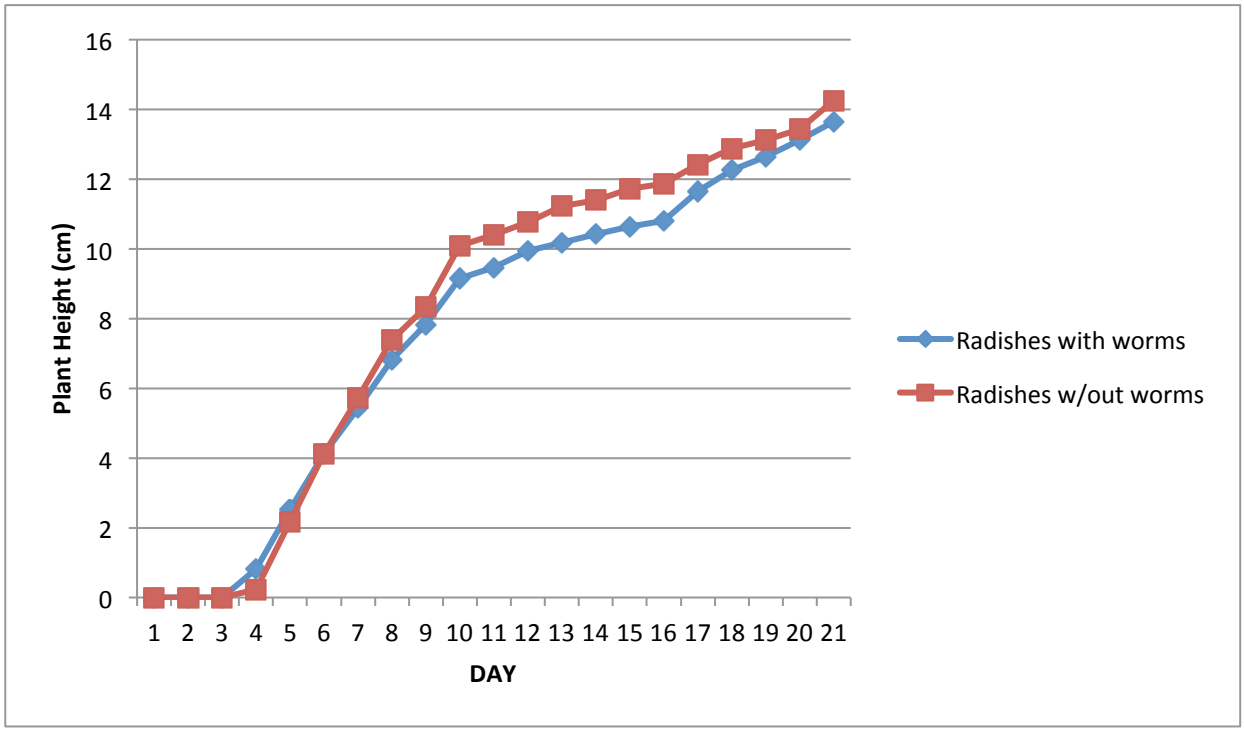
Tape

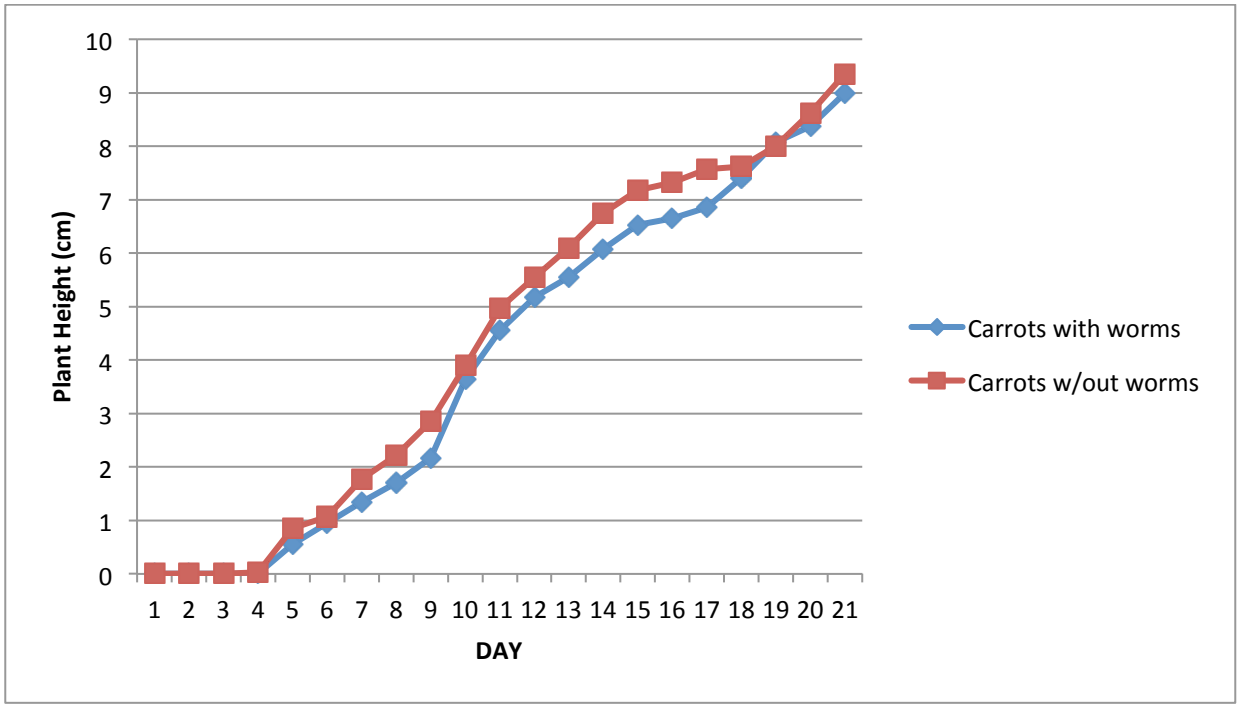
Camera

Natural sunlight

RESULTS


12
10
8
6
4
2
0
Plant Height (cm)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
DAY
Cilantro with worms
Cilantro w/out worms


16
14
12
10
8
6
4
2
0
Plant Height (cm)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
DAY
Radishes with worms
Radishes w/out worms



These results show that cilantro with worms grew an average height of 9.15cm after 21 days, while cilantro without worms grew 10.425cm. Radishes with worms grew an average height of 13.65cm, while radishes without worms grew 14.25cm. Carrots with worms grew an average height of 9.0cm, while carrots without worms grew 9.35cm. In all three cases, based on the data, the plants grew better without earthworms present in the soil.

CONCLUSION

Based on the results of my experiment and the data collected, my hypothesis of 'when earthworms are present in the soil plants will grow better because the earthworms digest soil and organic matter which is returned to the soil as "castings" which are rich in nutrients and beneficial for plant growth' was disproven. The overall data results showed that all three plants (cilantro, radish and carrot) without worms grew better than those which contained worms in the soil. I believe this happened because perhaps the amount of water used daily (1 tablespoon per cup of seeds) was too much or not enough, resulting in soil that was not the ideal environment for the earthworms. Soil that was not of the ideal consistency may be difficult for the earthworms to burrow through it, produce castings, and turn over the soil.

Overall I believe my experiment worked well. I controlled the amount of soil and water, and the number of seeds and worms placed in each planter, so I am confident that each of the planters of seeds were handled consistently and were exposed to the same variables. Additionally, I selected seeds with similar germination periods, and ensured that all of the seeds were exposed to the same type and amount of natural light. The only difficulty I had was determining whether or not the amount of water being given to the seeds each day was sufficient.

After reviewing the results of my experiment, the one new question I have is whether or not there is a particular type of soil, or soil consistency, earthworms seems to prefer. In order to improve my project, if I were to do it again, I would do additional research into the type of soil, and soil consistency, that earthworms thrive best in and make any necessary changes to the materials used in my experiment.

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