The Effect of Aspirin on Plant Growth

Botany

Experimental Investigation

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Signature of Sponsoring Teacher

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Signature of School Science Fair Coordinator

Student 2
8445 S. Kolin
Durkin Park
Chicago, IL 60652
Grade 8

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PURPOSE

The purpose of my science fair project is to find out if watering plants with water containing dissolved aspirin will help them to grow better. This was tested by growing three different kinds of seeds in planters containing 354mL of soil. One set of seeds was watered using room temperature water containing no aspirin. A second set of seeds was watered using room temperature water containing one half of an aspirin (162.5 mg) per cup of water. A third set of seeds was watered using room temperature water containing one full aspirin (325 mg) per cup of water. The control group was the set of seeds watered with plain water (containing no aspirin).

HYPOTHESIS

When the ideal concentration of aspirin is present in the water used to water plants, I believe plants will grow better because aspirin is an organic acid and a plant hormone which helps to stimulate the growth of plants as well as aids in their development and in the process of photosynthesis.

Review of Literature

People from many different professions, and for many different reasons, are interested in plant growth and production. Farmers, scientists, and even backyard gardeners are continuously searching for ways to improve, increase, and speed up plant production. Much research has been done regarding plant hormones and the part they play in plant growth. Plant hormones are not nutrients or medicines, they are chemicals that promote and influence the growth and development of cells and tissues. Aspirin is another name for the chemical acetylsalicylic acid, which is very similar to the plant hormone salicylic acid. There are five major classes of plant hormones. Each of the classes occur naturally in plants, and serve a specific purpose: abscisic acid, auxins, cytokinins, ethylene, and gibberellins (www.pontotriplio.org). Abscisic acid is a plant growth regulator. It is found in high concentration in freshly fallen leaves and plants under stress. Abscisic acid helps with seed dormancy and inhibiting growth. Auxins influence cell enlargement, bed formation, and root initiation. Cytokinins influence cell division and shoot formation. Ethylene inhibits leaf expansion in new seedlings until the new shoots are exposed to light, at which point ethylene production decreases. Gibberellins are particularly important in seed germination and food production. Given the benefits of these naturally occurring hormones, there is also a large business built around the production of artificial growth hormones, like those that are found in commercially available plant foods and fertilizers.

After reviewing the effect of hormones on plants, one may also consider whether or not medications could also be used to promote plant growth. Medications promote healing and growth in humans, so why not plants as well? For instance, does aspirin help plants grow better?

Aspirin, also called 'acetylsalicylic acid' is a pharmaceutical drug. Aspirin is in the family of salicylates (salicylic acids – denoted as SA). It is a colorless crystalline organic acid and is used in synthesis. It is also a plant hormone. Salicylic acid is found throughout the makeup of plants. It is known to stimulate the growth of plants, their development, transpiration, and photosynthesis. Transpiration and photosynthesis will be explained in more detail later. Spraying plants with water including crushed aspirin has also been found to ward off insects, helping to protect plant leaves. Aspirin is one of the most commonly used drugs in the world. In humans, it is widely used to relieve pain caused by headaches and arthritis, to reduce fevers caused by infection, and to reduce inflammation caused by illness or injury. Aspirin also reduces blood clotting, and is therefore used as a routine medication to reduce the chance of heart attack and stroke. Salicylic acids are found in many creams, gels, ointments, moisturizers, cleansing bars, soaps, and shampoos. Salicylic acids are in a medication group known as the keratolytic group, which are known to separate the bond between skin cells, making them natural a exfoliator. Given these properties, salicylic acid can be used for a variety of medical applications, including: treatment of warts and calluses, treatment for skin problems or irregularities, and preventing and controlling breakouts.

Salicylic acids, including aspirin, can actually be thought of as having its beginnings in the plant/agricultural world. Earlier in history, willow bark was commonly used to relieve pain and fever. Willow bark contains a chemical that the human body converts to a salicylate, the same chemical family that aspirin belongs to. In the 1800's, French chemist Charles Gerhardt first produced aspirin in a laboratory. The Bayer Company is ultimately credited with patenting 'Aspirin' as it is known in the United States. Knowing that salicylic acid is found naturally in plants, and that we have seen the benefits that salicylates (such as aspirin) provide

for people, it is reasonable to construct a hypothesis that aspirin would have a similar positive impact on plants.

A critical piece of research that contributed to my study of the effects of aspirin on plant growth was an experiment I conducted last year. The experiment was a first attempt to utilize aspirin in the process of growing plants to determine the impact, positive or negative, that it would have. While I noted above that my research supported a hypothesis that the use of aspirin would contribute positively to plant growth, my initial experiment did not yield those results. In reviewing the details and results of my experiment, a question came to mind that I had not originally considered. Would the amount of aspirin used impact the results? In my original experiment I simply included a single aspirin tablet per cup of water used to nourish the growing plants. In order to determine if this was in fact a contributing factor, I expanded my experiment this year to include 2 different concentrations of aspirin per cup of water. Additionally, the plant germination requires a lot water to be successful, and I had an additional concern that the amount of water I used in my initial experiment may not have been sufficient. As a result, I made adjustments in this experiment to both increase, and more closely monitor, the amount of water used when feeding the plants.

As noted earlier, salicylic acid aids in plant transpiration and photosynthesis. Transpiration is the process by which moisture is carried through plants from their roots to small openings (pores) on the underside of their leaves (www.water.usgs.gov). Once there, the moisture changes to vapor and is released into the atmosphere. You can think of transpiration as being the same as water evaporation from plant leaves. Studies have shown that approximately 10 percent of the moisture in the atmosphere is from plant transpiration. For reference, the other 90 percent is the result of evaporation from oceans, seas, and smaller bodies of water (lakes,

rivers, streams). Plant transpiration is a largely 'invisible' process. While water is evaporating off the surface of plant leaves and being added to the surrounding air, you do not see plant leaves 'sweating' and cannot see the water in the air. During a growing season, a plant will transpire many times more water than its weight. As an example, an acre of corn produces about 3,000 – 4,000 gallons of water each day!

Photosynthesis is the process in which green plants make their food (Burnie, 1998). It is the main job of a plant's leaves. Green plants obtain energy from light and combine it with water and carbon dioxide found in the air. This process is what makes the food for plants. The result of the photosynthesis process (combining light, water, and carbon dioxide) are sugars. These 'sugars' turn into starch, which is then stored in the cells of plant leaves until it is needed for food. An obvious benefit of the photosynthesis process is that plants do not need to 'find' food because they can make it for themselves using the light and energy gained from the sum in combination with carbon dioxide and water. Additionally, during the process of making their food, plants release oxygen into the air which animals (including people) and plants need to live.

As noted above, the process plants use to make food requires water, carbon dioxide, and a third critical component – light. There are two forms of light that can be considered – artificial light and natural light. Artificial light is most easily explained as 'man-made'. Sources of artificial light include light bulbs and candles. Natural light is just that – naturally occurring, not artificially created by people. 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. The clearest example of natural light is the sun. While plants can be grown in artificial light or sunlight (natural light), natural light is preferred as it provides added benefits. Artificial light lacks the complete spectrum of light provided by the

sun. Using humans as an example, aside from the light and heat that we derive from sunlight, it also helps the body to produce vitamin D, a contributor to healthy bones and teeth.

One of the Earth's most important resources is soil (Richardson, 2002). Soil provides an environment for plants and trees to thrive and grow. Plants help turn carbon dioxide into oxygen that people use to breathe. Soil contains nutrients that plants and trees need to grow healthily. Most of the plants we commonly grow gather needed nutrients from water and soil. Three nutrients found in soil help plants get what they need to grow: nitrogen, phosphorus, and potassium. Nitrogen is what helps plants grow their leaves and is a component in the chlorophyll that gives the leaves their green color. Chlorophyll is a green pigment that, in addition to providing plants' characteristic green color, also allows them to produce food needed for growth. Chlorophyll is used in the process of converting energy from the sun into chemical energy stored in the form of starch. Phosphorus helps plants and trees to grow their seeds and flowers and build strong roots. Plants that have a lot of phosphorus are said to produce larger flowers. Potassium helps plants and tree roots to grow stronger. Potassium is also used to help plants make chlorophyll and protects them from disease.

Once seeds are planted in soil, and properly nourished, germination will occur. Germination is when a seed begins to sprout. When the germination process begins plants need a lot of water. The water produces a chemical charge that enables the embryo within the seed to store food for energy and growth. The water also causes the baby seed (embryo) to enlarge and split the seed coat open. Germinating seeds requires a large amount of oxygen, and subsequently gives off carbon dioxide. One part of the embryo, called the radical, comes out and grows downward producing the plant's roots. Another part, called the plumule, grows upward and turns into the shoot of the plant. A food store, called an endosperm, surrounds the new baby

plant. After the shoot and roots are formed, the first plant part you see is called the 'cotyledons'. They help feed the new seedling until it is able to make its own plant.

Why should we be concerned with finding new ways to help plants grow better and stronger? Agriculture, defined as the cultivation of plants and animals for the benefit of humans, is one of the oldest and largest industries in the world. Agriculture is said to be one of the world's most important industries. Agriculture is what provides the world with food, as well as clothing and shelter. Approximately half of the workers in the world are employed in the agriculture industry – considerably more than any other industry or profession. The work of those in the agriculture industry is demanding, but critical to our survival. Given these realities, there is a constant need to look for improvements and innovations to bring to the agriculture industry to help increase plant production and crop sustainability.

Before agriculture was developed, people spent most of their time continually searching for food, which left little time for anything else. As agriculture developed and production became larger, fewer people were needed to produce the food. However, most of the scientific improvements that have occurred have been in industrial nations. In many nations that are not industrialized, people continue to farm as their ancestors did many years ago. The non-industrialized countries that continue to farm using old-fashioned methods have difficulties increasing their production of food to meet ever-increasing demand. Increasing food production is a necessity needed to keep up with the rapid population growth of today's world. Helping these nations learn to modernize and increase their production is important. Farms provide the world with almost all of its food, most of which comes from crops. If aspirin was the key to healthier, faster growing plants, it would definitely help these nations produce better quality products, in larger quantities, and at a faster rate.

PROCEDURE

1. Take 9 (473mL) planters and label them as follows: radish with plain water, radish with ½ aspirin, radish with 1 aspirin, broccoli with plain water, broccoli with ½ aspirin, broccoli with 1 aspirin, carrot with plain water, carrot with ½ aspirin, and carrot with 1 aspirin.

2. Fill each planter with 236mL of soil.

3. Add 5 seeds to each planter matching the labels (radish, broccoli & carrot).

4. Top each of the planters with an additional 118mL of soil.

5. Place all 9 planters in natural light.

6. Add one tbsp. of water daily to each planter (plain water in 3, ½ aspirin water in next 3, 1 aspirin water in last 3)

7. Measure and record the growth of the longest plant in each planter using a centimeter ruler daily for 30 days.

MATERIALS

(9) 473mL planters

3,194mL of soil (355mL per planter)

Aspirin tablets

15 radish seeds

15 broccoli seeds

15 carrot seeds

Sticky notes to label planters

Marker

1 tbsp. measuring spoon

1 ruler

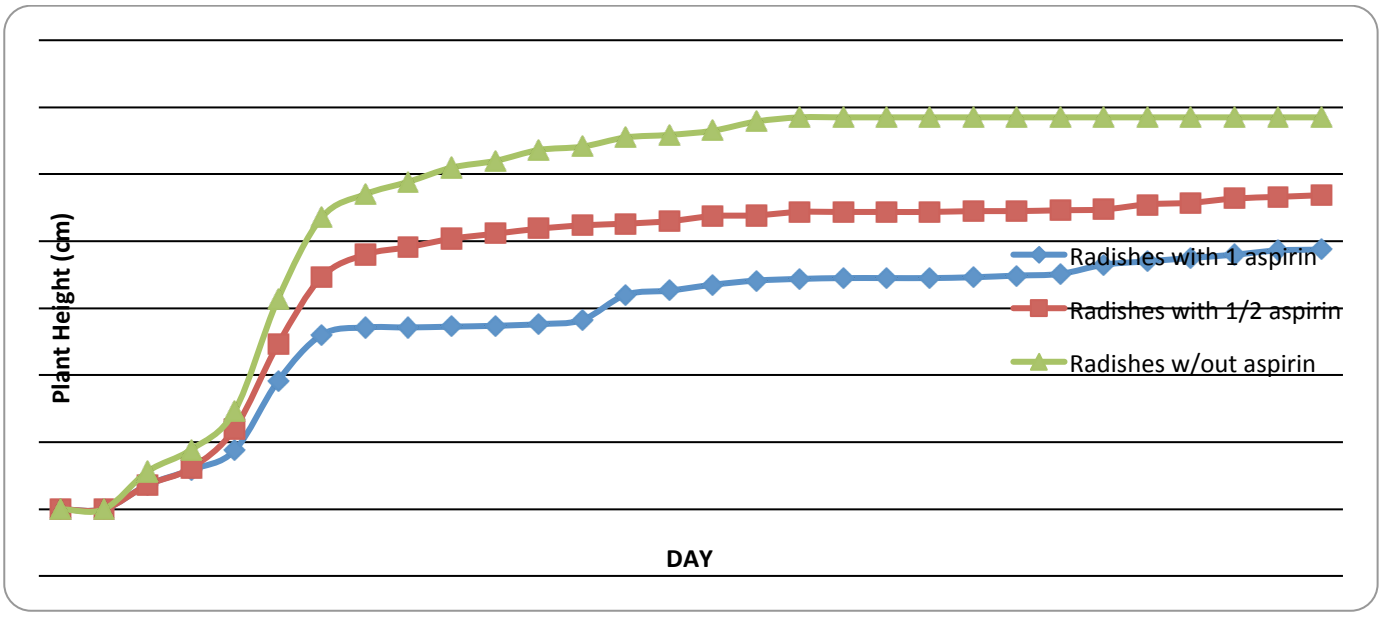
Water

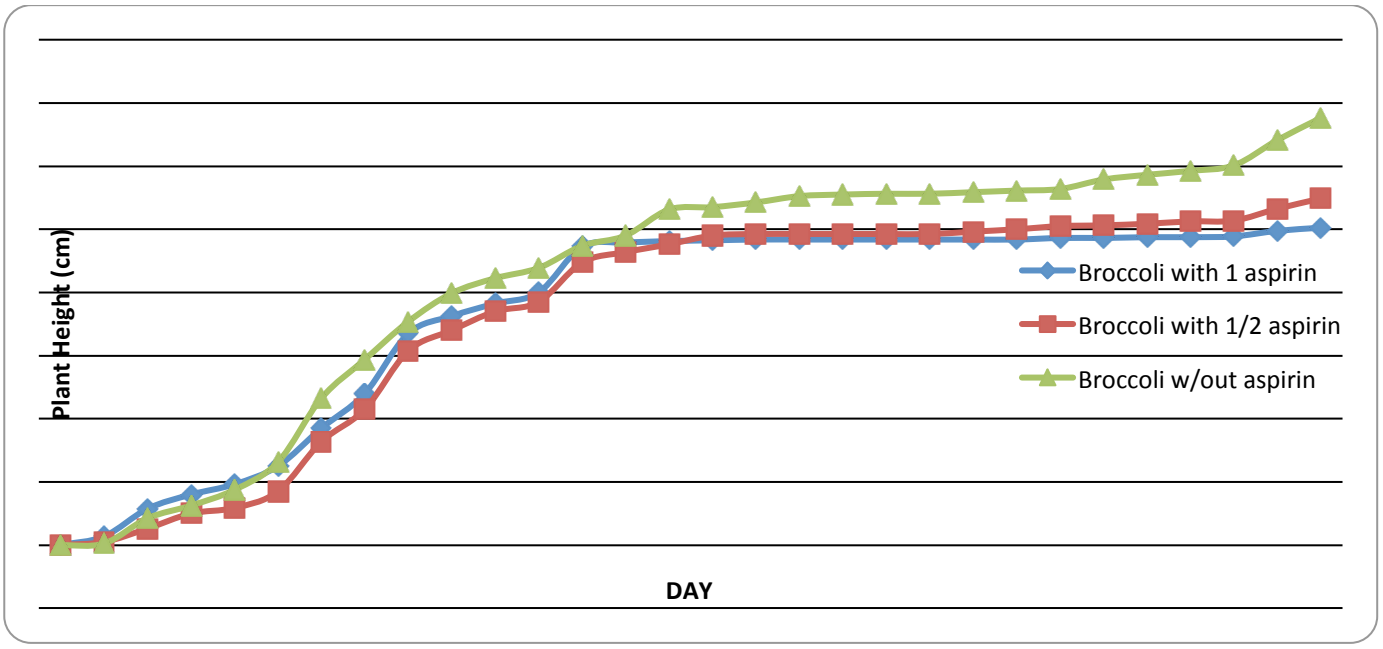
Tape

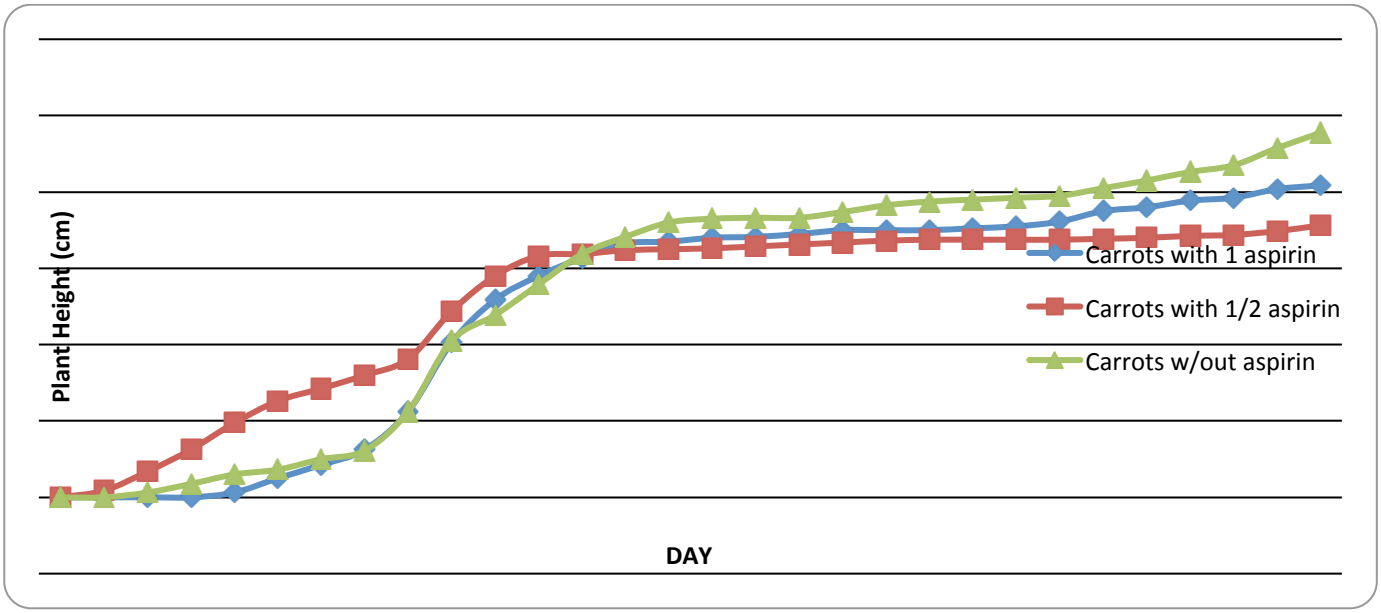
Camera

Natural sunlight

RESULTS


Plant Height (cm)
DAY
Radishes with 1 aspirin
Radishes with 1/2 aspirin
Radishes w/out aspirin


Plant Height (cm)
DAY
Broccoli with 1 aspirin
Broccoli with 1/2 aspirin
Broccoli w/out aspirin



These results show that:

- Radishes with 1 aspirin grew an average height of 7.75cm after 30 days, radishes with ½ aspirin grew 9.375cm, and radishes with no aspirin grew 11.7cm.
- Broccoli with 1 aspirin grew an average height of 10.05cm after 30 days, broccoli with ½ aspirin grew 10.975cm, and broccoli with no aspirin grew 13.525cm.
- Carrots with 1 aspirin grew an average height of 8.175cm after 30 days, carrots with ½ aspirin grew 7.125cm, and carrots with no aspirin grew 9.55cm.

In all three cases, based on the data, the plants grew better without any aspirin being used in the water.

CONCLUSION

Based on the results of my experiment and the data collected, my hypothesis that watering plants with water containing dissolved aspirin will help them to grow better was disproven. The overall data results showed that all three plants (radishes, broccoli, and carrots) grew better watered with plain water than when watered with water containing aspirin.

Overall I believe my experiment worked well. I controlled the amount of soil, water, aspirin, and natural light so I am confident that each of the planters of seeds were handled consistently and were exposed to the same variables. The only difficulty I had was determining what the appropriate amount of aspirin should have been given the size of the planter and the types of seeds used.

After reviewing the results of my experiment, a question I have is whether or not misting the plant leaves with the aspirin water would have been better than adding it to the soil each day. In order to improve my project, if I were to do it again, I would consider adding a fourth set of plants where I simply misted the leaves with water (with and without aspirin) rather than adding it to the soil.

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