



SCIENCE FAIR KIT: NATURAL ANT REPELLENTS

Project Summary: Testing the Effectiveness of Natural Ant Repellents

For this project, you will follow the scientific method to test how effective one or more natural repellents are at repelling ants. Although natural repellents have a limited effect on minor ant infestations, it is recommended that you contact a pest professional when dealing with a consistent ant problem.

Age Range:

Third grade (with adult supervision) to eighth grade.

Time Required:

4 days to 2 weeks, depending upon the question you choose and how many experiments you try.

Safety

Some of the repellents present minor hazards. An adult should handle repellents and other materials listed with this caution symbol:



Time of Year:

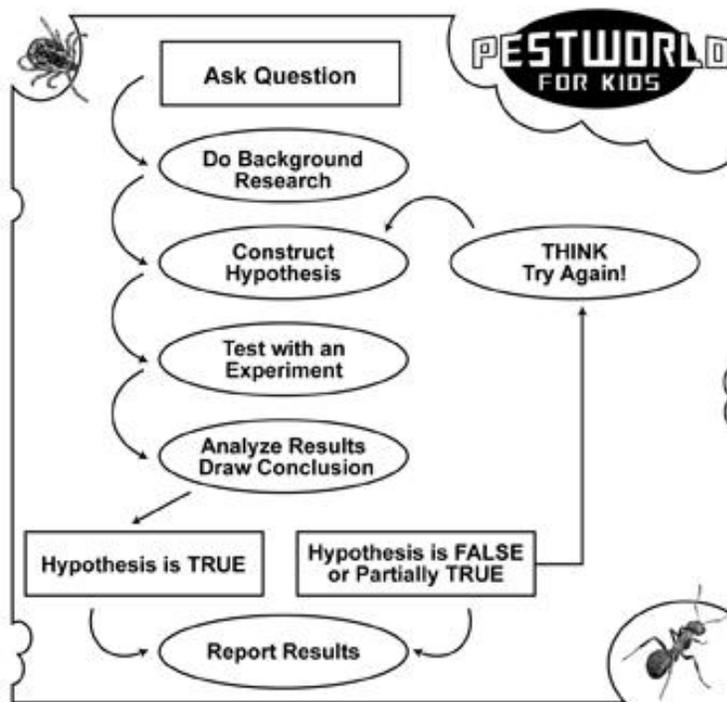
When ants are active, most likely in the spring or late summer months.

Material Availability:

Most materials are readily found in home kitchens. Depending upon the repellent you're investigating, a trip to a hardware or garden store may be needed.

How Scientists Think

The great thing about science is that there can be many answers to a single **question**. To figure out which answer is most correct, scientists follow a process called *The Scientific Method*. The Scientific Method is a series of steps that helps scientist identify a question, think of a possible answer (the **hypothesis**) and then use **experiments** to test that answer (the **hypothesis**) to see if it is true.



The important thing to remember is that all scientists often need to try several experiments until one can be sure a hypothesis (a possible answer) is true or not.

These steps walk you through how to think like a scientist. As you think like a scientist, you'll test one or more natural repellents to see which is effective at keeping ants out of your home.



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Ask a Question:

Every scientific investigation begins by asking a question. Picking a good question to ask helps you to define the problem you want to investigate and develop a hypothesis to test. A good question meets the following criteria:

- Is the answer to the question something you can measure?
- Does the question ask one or more of the following: who, what, when, where, why, how, or which?

Before deciding on a question, consider the difficulty level of the project you'd like to undertake as well as the amount of time you have. Here are some from which you can choose:

Easy:

Test one natural repellent.

Approximate time = 4 days

Sample Question: How well does this natural repellent keep ants away?

Medium.

Test two or more natural repellents and determine which is more effective.

Approximate time = 1 week.

Sample Question: Which repellent is more effective at repelling ants?

Challenging

Research safe combinations and create your own mixture of natural repellents to test in your home and other locations with ant pests.

Approximate time = 1-2 weeks.

Sample Question: Are some repellents more effective in pairs than on their own?

Which pairs are the most effective?

Do Background Research

A little background research will provide you the opportunity to find necessary information about the organism and/or products you plan to test.

To begin to answer your question, you'll need both general information about ants as well as specific information about each species' diet, habitat, impact as well as how to prevent an infestation.



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Glossary | Terms To Know

It will be helpful to know some or all of these terms so you can be sure to understand everything you read. You can research these terms in the PestworldforKids.org glossary, using another online dictionary like Merriam-Webster.com, or at a local library.

- Ant
- Boric Acid
- Catnip
- Colony
- Diatomaceous earth
- Glue boards
- Hypothesis
- Insecticidal Soap
- Pest
- Repellent

General Information on Ants

Although ants are frustrating when they get into your home or when you're having a picnic, ants do help the environment. They are also social insects, which means they live in large **colonies** or groups. Depending on the species, ant colonies can consist of *millions* of ants.

There are three kinds of ants in a colony: The queen, the female workers and males. The queen and the males have wings while the workers don't have wings. The queen is the only ant that can lay eggs. The male ant's job is to **mate** with future queen ants and they do not live very long afterwards. Once the queen grows to adulthood, she spends *the rest of her life* laying eggs! Depending upon the species, a colony may have one queen or many queens.

Ant colonies also have soldier ants that protect the queen, defend the colony, gather or kill food and attack enemy colonies in search for food and nesting space. If they defeat another ant colony, they take away eggs of the defeated ant colony. When the eggs hatch, the new ants become the "slave" ants for the colony. Some jobs of the colony include taking care of the eggs and babies, gathering food for the colony and building the anthills or mounds.

Ants have a wide variety of nesting habits and food preferences. Some ants build their nests in soil, producing mounds while others nest in homes behind trim, baseboards, countertops and similar places. Still other ants nest in decaying or moisture damaged wood.

Ants feed on different types of food including starches, meats, fats and sweets. Many ants also feed on honeydew, a sweet liquid produced by aphids and scale insects. Knowledge of ant food and nesting preferences is very important in controlling ant colonies.

Most ants are primarily a nuisance and cause little damage. Some, such as Pharaoh ants, may infest food. Others, like carpenter ants, can weaken wood in structures. Generally, there are no diseases associated with ants.



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FAST FACTS

- There are more than 12,000 species of ants all over the world.
- An ant can lift 20 times its own body weight. For example, if a second grader were as strong as an ant, he or she would be able to pick up a car!
- When **foraging**, ants leave a **pheromone** trail, so that they know where they've been, either to avoid repeating the same paths or to return to a reliable food source. This scent also helps them to tell the difference between other members of the colony and intruders.
- Some queen ants can live for many years and have *millions* of babies!
- Queen ants have wings, which they shed when they start a new nest.
- Ants don't have ears. Ants "hear" by feeling vibrations in the ground through their feet.
- Ants don't have lungs. Oxygen enters through tiny holes all over the body and **Carbon Dioxide** leaves through the same holes.
- When ants fight, it is usually to the death!
- When the queen of the colony dies, the colony can only survive a few months. Queens are rarely replaced and the workers are not able to reproduce.



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Carpenter Ants

Carpenter Ants get their name because they build their nests in wood and can cause significant damage to the wood in your house. There are nine types of carpenter ants throughout the U.S. and they range in size from one-quarter inch (about the width of a pencil) for a worker carpenter ant to three-quarters of an inch (about the size of a quarter) for a queen carpenter ant.

Size: 5/8"
Shape: Segmented, Oval
Color: Range in color from red to black.
Legs: 6
Wings: Varies
Antenna: Yes

Each colony is established by a single, fertilized queen. She starts her nest in a cavity in wood, where she raises her first brood of workers. She feeds them saliva and does not leave the nest or feed herself during this time.

When they are ready, those workers then get the job of gathering food to feed the next generation. Once mature, this first generation of worker ants work to increase the food supply for the colony. The colony population grows very rapidly. A colony can eventually produce 2,000 or more workers.

Diet

Carpenter ants do not eat the wood they remove during their nest-building activities, but deposit it outside entrances to the colony in small piles.

The diet of carpenter ants includes living and dead insects, meat, fats and sugary foods of all kinds, such as honeydew and nectar from plants.

Habitat

Carpenter ants build nests anywhere they can find water and moldy or damp wood, such as tree stumps, firewood or in the plants around your house. Carpenter ants also build nests inside, usually entering buildings through wet, damaged wood, although it isn't uncommon for them to adapt to drier environments.

Impact

Carpenter ants don't carry disease, but when building a nest inside a home, Carpenter Ants dig smooth tunnels inside the wood. These tunnels weaken the wood and potentially damage the wood that keeps the house standing. This kind of damage can be very expensive to fix.

Prevention

- * Eliminate standing water. Pests, such as ants, mosquitoes and termites, are attracted to moisture.
- * Keep tree branches and other plants cut back from the house. Sometimes pests use these branches to get into your home.
- * Make sure that there are no cracks or little openings around the bottom (foundation) of your house. Sometimes pests use these to get into your home.



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* Make sure that firewood and building materials are not stored next to your home. Pests like to build nests in stacks of wood.



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Argentine Ant

This species of ant is native to Argentina and Brazil and was probably introduced to the United States in freight ships around the 1890's. These ants can be found in southern states and in California, Illinois, Maryland, Missouri, Oregon and Washington.

Size: 1/16"-1/4"
Shape: Segmented, Oval
Color: Dark brown to black; shiny
Legs: 6
Wings: Varies
Antenna: Yes

Diet

Argentine Ants prefer sweet substances but will eat almost anything including meats, eggs, oils and fats. Also, when **foraging** for food, Argentine ants leave **pheromone** trails everywhere they go, instead of just from nest to food source. This habit ensures they do not waste time visiting the same area twice. While in other ant species worker ants are primarily responsible for gather food, Argentine queens also assist with **foraging** for food.

Habitat

Argentine ant colonies are located in wet environments near a food source. These colonies can grow to monumental size, sometimes covering entire habitats, such as an entire garden or your whole back yard.

Impact

Argentine ants do not pose a health threat but they can contaminate food by leaving their bodily waste behind.

Prevention

- * Eliminate standing water. Pests, such as ants, mosquitoes and termites, are attracted to moisture.
- * Keep tree branches and other plants cut back from the house. Sometimes pests use these branches to get into your home.
- * Make sure that there are no cracks or little openings around the bottom (foundation) of your house. Sometimes pests use these to get into your home.
- * Make sure that firewood and building materials are not stored next to your home. Pests like to build nests in stacks of wood.



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Odorous House Ants

This ant gets its name from the strong, rotten coconut-like smells it gives off when crushed and the fact that they commonly nest in or around houses. Native to the United States, these ants are very social - living in colonies of up to 100,000 members.

Size: 1/16"-1/8"
Shape: Segmented, Oval
Color: Brown or Black
Legs: 6
Wings: Varies
Antenna: Yes

Diet

Odorous house ants like to eat dead insects and sugary sweets, especially melon.

Habitat

Typically living for several years, these ants commonly make their homes in exposed soil, under stones, logs, mulch, debris and other items. They will also nest in wall and floor cracks.

Impact

Odorous House ants do not pose a health threat, but they can contaminate food by leaving waste behind.

Prevention

- * Eliminate standing water. Pests, such as ants, mosquitoes and termites, are attracted to moisture.
- * Keep tree branches and other plants cut back from the house. Sometimes pests use these branches to get into your home.
- * Make sure that there are no cracks or little openings around the bottom of your house. Sometimes pests use these to get into your home.
- * Make sure that firewood and building materials are not stored next to your home. Pests like to build nests in stacks of wood.



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Pavement Ants

Although these ants can live inside, they get their name because they make their nests in or under cracks in pavement. They are typically found in the eastern half of the United States, as well as California and Washington. Pavement ant colonies average 3,000 to 4,000 members and have several queens.

Size: 1/8"
Shape: Segmented, Oval
Color: Dark Brown to Black
Legs: 6
Wings: Varies
Antenna: Yes

Diet

These ants will eat almost anything, including insects, grease, seeds, honeydew, honey, bread, meats, nuts and cheese.

Habitat

This ant gets its name because it most commonly nests in soil next to and beneath cement slabs, sidewalks, patios and driveways. Indoors, pavement ants nest under a building's foundation and within hollow foundation walls.

Impact

Pavement ants do not pose a health threat, but they can contaminate food by leaving waste behind.

Prevention

- * Eliminate standing water. Pests, such as ants, mosquitoes and termites, are attracted to moisture.
- * Keep tree branches and other plants cut back from the house. Sometimes pests use these branches to get into your home.
- * Make sure that there are no cracks or little openings around the bottom of your house. Sometimes pests use these to get into your home.
- * Make sure that firewood and building materials are not stored next to your home. Pests like to build nests in stacks of wood.



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Red Imported Fire Ants



CAUTION: Red Imported Fire ants can sting.

Do NOT use as your test subject.

Size: 1/8"-3/8"
Shape: Segmented, Oval
Color: Dark Reddish
Brown
Legs: 6
Wings: Varies
Antenna: Yes

Red Imported Fire Ants are more aggressive than other ant species and have a painful sting. These ants and their telltale mound nests should be actively avoided.

Cool fact: Red Imported Fire ants can adapt to many climates and conditions in and around their environment. For example, if the colony senses increased water levels in their nests, they will come together and form a huge ball or raft that is able to float on the water!

Diet

They primarily feed on vegetation.

Habitat

Red Imported Fire ants will build their nests in mounds of soil outdoors, in landscape areas or near a building's foundation. They occasionally enter buildings through holes or cracks in walls and foundations.

Impact

The sting of a Red Imported Fire ant is painful and often results in a raised welt that becomes a white blister. Persons allergic to insect stings will react more severely. They are frustrating, not only because of the physical pain they can inflict, but because their mound-building activity can damage plant roots and lead to loss of crops.

Prevention

- * Eliminate standing water. Pests, such as ants, mosquitoes and termites, are attracted to moisture.
- * Keep tree branches and other plants cut back from the house. Sometimes pests use these branches to get into your home.
- * Make sure that there are no cracks or little openings around the bottom of your house. Sometimes pests use these to get into your home.
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Information on Natural Ant Repellents and Their Application

A natural ant repellent is any naturally occurring chemical, plant or product that has known ant-repelling properties.

Natural Repellent	General Information	Specific Application
Boric Acid and Sugar Mixture	<p>Boric Acid dissolves in the sweet syrup. Once eaten by the ant, it's carried back to the colony and fed to other ants. As the boric acid dries inside the ant it crystallizes and cuts through their intestinal tract, killing the ant. Boric acid is found in most grocery, drug and hardware stores.</p> <div style="text-align: center;">  </div> <p>CAUTION: Boric acid can be toxic to humans in certain doses. Have an adult prepare this mixture.</p>	<p>The recipe is: 4 teaspoons of boric acid, 3 cups of hot water (to dissolve the boric acid) and 1 cup of sugar. Once dissolved, pour a teaspoon of the mixture onto plastic disposable plates or shallow bowls. Old lids with narrow lips will work just fine. Place at points of entry and exit of the home.</p>
Catnip (fresh)	<p>Catnip is a perennial herb belonging to the mint family and grows wild in most parts of the United States. Catnip is native to Europe and was introduced to the United States in the late 18th century. It is primarily known for the stimulating effect it has on cats, although some people use the leaves in tea, as a meat tenderizer and even as a folk treatment for fevers, colds, cramps and migraines. Scientists debate whether nepetalactone (the oil that gives catnip its odor) acts as an insect repellent.</p> <p>It can be found in many garden or pet stores. No precautions are needed.</p>	<p>Crush and cut up the fresh plants and sprinkle along ant trails and at points of entry and exit of the home.</p>
Diatomaceous Earth (DE)	<p>Diatomaceous earth is the finely ground fossil remains of fresh water diatoms. It is more of an insecticide than a repellent. When ants swallow</p>	<p>Carefully sprinkle the dust at the locations of ant entry and exit.</p>

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Natural Repellent	General Information	Specific Application
	<p>DE, its rigid structures cut through the ant causing them to dehydrate and eventually kills them.</p> <p>DE can be found in most hardware stores.</p>  <p>CAUTION: ASK AN ADULT FOR HELP! DE is dangerous to breathe for long periods and can cause drying of hands. Use plastic gloves and a scarf over your mouth and nose when handling DE.</p> <p>DO NOT USE if you have household pets or young children that could get into your experiment. Ask for an adult to assist in using the DE.</p>	<p>Clean up extra DE with a wet paper towel and discard.</p>
<p>Glue Boards</p>	<p>Glue boards effectively trap ants by attracting them with a sweet smell. Once the ant walks upon the glue they are permanently stuck to the board. These can be purchased at most hardware stores.</p>  <p>CAUTION: The traps are VERY sticky. You can clean your sticky hands with room-temperature cooking oil. Adults should clean hard surfaces with paint thinner or mineral spirits.</p>	<p>Place the glue board at the point of entry and/or exit, or along ant trails.</p>
<p>Spray Glue Adhesive</p>	<p>Create your own glue boards, or gluey orange and apple slices etc., using this special spray adhesive. It can be found in hardware stores.</p>  <p>CAUTION: These traps are VERY</p>	<p>Place the glue board (or gluey trap of your choice) at the point of entry and/or exit, or along ant trails.</p>



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Natural Repellent	General Information	Specific Application
	sticky. You can clean your sticky hands with room-temperature cooking oil. Adults should clean hard surfaces with paint thinner or mineral spirits. Have an adult apply the adhesive for your gluey trap.	

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Natural Repellent	General Information	Specific Application
Ground Cinnamon	<p>Chemicals in cinnamon oil may effective at repelling ants.</p> <p>No Precautions. Found in most kitchens and grocery stores.</p>	<p>Sprinkle along ant trails and at points of entry and exit.</p>
Insecticidal soaps	<p>Insecticidal soaps are defined as potassium fatty acid soaps and are used to control many plant pests. It is typically sprayed on plants in the same manner as other insecticides. They have low toxicity to humans, but can cause a mild irritation to skin and eyes.</p> <div style="text-align: center;">  </div> <p>CAUTION: Read the safety precautions on the container. It can be purchased at most hardware stores. You may need to wear gloves and eye protection. Have an adult help you with this product.</p>	<p>Mix as recommended on the container and apply as directed to points of entry and exit. Usually insecticidal soaps are used as a 2% solution (2 parts soap to 90 parts water - about 2 oz. per gallon).</p>
Spearmint (fresh)	<p>Chemicals in spearmint oil may effective at repelling ants</p> <p>No Precautions. It can be found in grocery stores and garden stores.</p>	<p>Crush and cut up the fresh plants and sprinkle along ant trails and at points of entry and exit.</p>



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Construct a Hypothesis

A hypothesis is an educated guess about how things work. A good hypothesis is based on research that gives you the information to make the best guess possible. Once you've gathered as much information as you can, you are ready to make a prediction or guess about what you think the answer will be to your question.

To put together the best possible guess that might answer your question, consider these factors:

- Which repellent will be most effective?
- What information did you find in your background research that helped you to come to this hypothesis?
- What evidence do you have to test this hypothesis?

You should state your hypothesis (guess) in a way that you can **easily measure**. For example:

If I _____, then _____ will _____.

If I apply 2 tablespoons of DE to the doorway, then 50% of the ants will be stopped.

Test Hypothesis with an Experiment

Testing with an experiment is the fourth part of the Scientific Method. There are two extremely important tasks you should be sure you do.

1) Make sure the test you are using is a **fair test**. A **fair test**, or experiment, is one that clearly changes only one factor (variable) while keeping all other conditions the same. The steps in your experiment should be clear and specific so that anyone could follow them and answer your question the same way you did.

2) It is also important to start with some **baseline observations**. For example, observe the pill bugs in their preferred habitat outside. What do you notice about their habitat? Is it in a shady or sunny location? Is it dry or moist? In this experiment you will select one (or more) changes to the pill bugs environment and test their preferences. Once you decide what to test, you will need to make your **baseline observations** so you know with what to compare your end results. To begin to put together your experiment, consider the following:

- How are the ants getting into your home or garage?
- Can you see a path where they are entering?
- Can you identify this species of ant?
- What ant repellent have you decided to test?
- What is the best way to apply your chosen ant repellent?

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Materials and Equipment

- observation and test site – your home, garage or other area where ants are considered a pest problem
- your chosen repellent(s) – see list above
- specific applicator for your chosen repellent(s) – see "specific application" note for the repellent you're investigation in the "Background Research" section
- Set of measuring spoons.



NOTE: Some of the repellents can cause irritation or other adverse reactions. Repellants should be disposed of properly after the completion of the project. Repellants SHOULD NOT be used for food.

- notebook and pencil for data collection
- digital camera to document procedure and ants studied
- magnifying glass to observe ants up close
- plastic gloves and eye protection
- Stopwatch, watch or clock for keeping track of how long you observe the ants
- Insect or ant identification guide. If the pictures in the background information aren't helpful, try the following:
 - The PestWorld for Kids website: <http://www.pestworldforkids.org>
 - A good online reference is: <http://www.ipm.ucdavis.edu/TOOLS/ANTKEY/>
 - Your local library for an insect identification guide for you to check out.

Procedure

1. First observe the areas around your home or garage to determine where/how ants are getting inside. If you are not going to do your experiment at home, find an adult to accompany you when you conduct your research.
2. Try to identify what type of ants you observe. An insect or ant identification guide would come in handy.
3. Take a photo of the ants, the spot where they are entering the home or garage and any other images to help determine your next steps and to communicate your final results.
4. Determine your baseline data. Record your observations of the ants. A few things to look out for are:
 - Where they are coming into the building?
 - How are the ants getting into the house or garage?
 - How many ants are coming and/or going?



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- Type of ant?
- Type of food ants found?

Anything you can learn about the ants' nesting behavior and what food attracts them will be your "control" or baseline observations. You'll compare the baseline observations to any observations after you put down the repellent.

5. Prepare the repellent(s) for use.
6. Remember, before applying your repellent, be sure to do a baseline observation of the area. Record your findings in a table like the one shown below.
7. Apply the repellent(s) along the path of entry and/or exit points.
8. Observe for a set period of time, perhaps 10 minutes, to notice the immediate reactions (if any) to the presence of the repellent(s) in their path. Record any observations.

Day 1 Time	Point of Entry	Trail	Point of Exit	Type of ant observed, other observations or reactions of ants
Baseline Observation: Number of ants observed before the addition of ant repellent				
9:00am Number of Ants observed in ten minutes				
12:00 noon Number of Ants observed in ten minutes				
3:00pm Number of Ants observed in ten minutes				
6:00pm Number of Ants observed in ten minutes				

9. Continue to observe at regular intervals throughout the day and at the same times during the next 3 days. Be sure to record any changes in their presence, their



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numbers and the types of ants coming in. Record all observations on a new chart, as the one below, for each day you observe. Try to observe at the same time each day, perhaps 9am, noon, 3pm and 6pm.

10. Take a few photos of your application of the natural repellent and the testing in action.

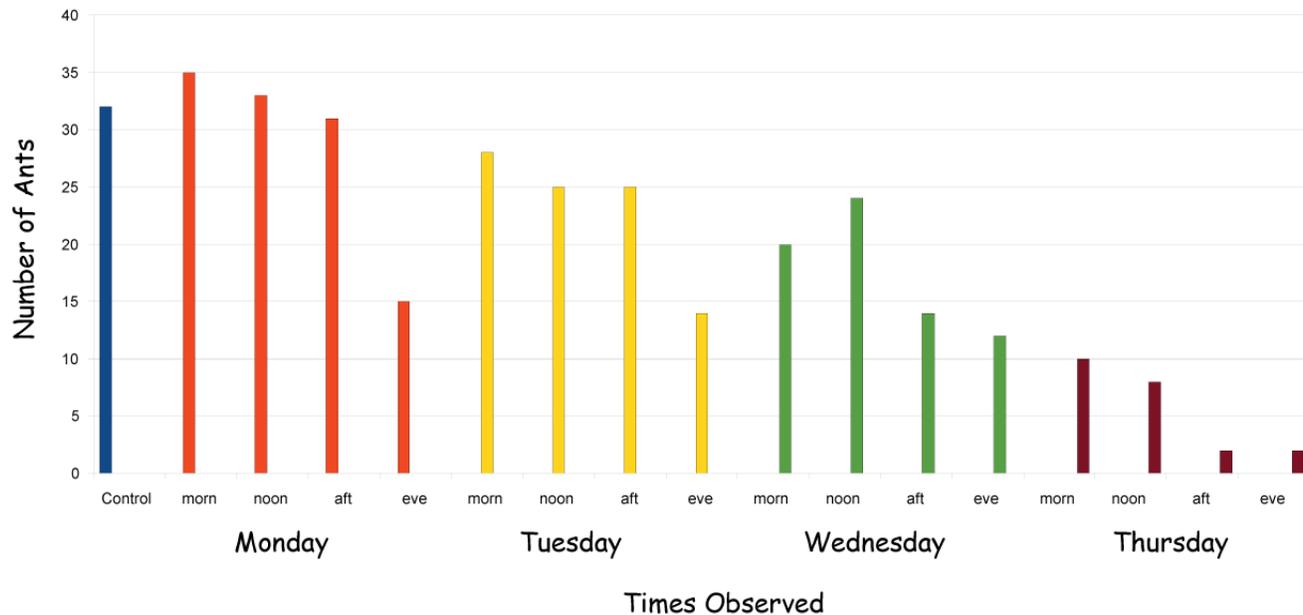
Day 2 Time	Point of Entry	Trail	Point of Exit	Type of ant observed, other observations or reactions of ants
9:00am Number of Ants observed in ten minutes				
12:00 noon Number of Ants observed in ten minutes				
3:00pm Number of Ants observed in ten minutes				
6:00pm Number of Ants observed in ten minutes				

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Analyze Data

Do you think your hypothesis (guess) was correct? Analyzing (reviewing) your data is the fifth step of the Scientific Method. Once you gather all of your data together you can figure out whether your experiment proves your hypothesis as true or disproves your hypothesis as false.

Number of Ants Observed in my Kitchen Window



1. Make a bar graph of your data to evaluate how well the repellent(s) worked. Label the bottom (X-axis) as the times you observed. Make the side (Y-axis) the number of ants observed.
2. Review the graph. Does it show a reduction in the number of ants entering the home or garage at that location? Did you notice ants finding a new path of entry?
3. Think about how your data confirm or challenge your hypothesis? Was your chosen repellent effective at repelling ants?
4. Are you satisfied with the results? Is there something you could do different in the experiment to get a different answer?
5. If you're not completely satisfied with the results, consider doing the experiment AGAIN but trying something slightly different.

For instance, instead of testing 1 teaspoon of a repellent, you could test more (like a tablespoon) or less (like a ½ teaspoon).

REMEMBER, scientists often change one little thing and repeat an experiment to be



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sure the data is providing enough information to conclude whether a hypothesis is true or not.

6. Once you're confident you have enough evidence to confidently say your hypothesis is true or not, you're ready to communicate your results.

Communicate Results

Share what you found out. The final step of the Scientific Method is to pull together everything you learned into a presentation to teach others.

Gather your data, pictures and graphs. Then follow these steps to create your poster, written report or other project:

1. Restate your question
2. List your background research
3. State your hypothesis
4. List your procedure and all the data you collected.
 - a. Be sure to include any additional tests you did in case you weren't satisfied with the first test.
5. Write up a concluding statement of 2 – 3 sentences that summarizes whether your ant repellent was or wasn't effective at repelling ants.
6. Include additional questions you (or other scientists) could research in the future. See the variations for further research listed in the "variations" section.
7. Be sure to note that if any of these repellents were effective, they were effective for a limited amount of time. For consistent infestations, pest management professionals should be contacted.

Make sure to label each step of the Scientific Method in your poster, report or project:

- Ask a Question
- Background Research
- Hypothesis
- Experimental Procedure
- Analyze Results and Draw Conclusions



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Variations

- Try an alternate repellent after your first experiment to determine if there are other natural repellents that work for this type of ant. Record if some repellents work better than others for the ants in your neighborhood.
- Create your own mixture of natural repellents to see if some are more effective in pairs than alone.
- Test other locations at friends' or family's homes, with their permission and an adult assisting in the application of the repellents.



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Correlations with NSTA Science Education Standards:

This kit correlates with the following:

Life Science

Grades K-4:

Life Science Content Standard C: The Characteristics of Organisms:

The behavior of individual organisms is influenced by internal cues (such as hunger) and by external cues (such as a change in the environment). Humans and other organisms have senses that help them detect internal and external cues.

Students observe and record the behavior of ants before (searching for food) and after the addition of a natural repellent (change in environment).

Grades 5-8

CONTENT STANDARD C: REGULATION AND BEHAVIOR

Behavior is one kind of response an organism can make to an internal or environmental stimulus. A behavioral response requires coordination and communication at many levels, including cells, organ systems, and whole organisms. Behavioral response is a set of actions determined in part by heredity and in part from experience.

Students observe the response ants exhibit when their environment is changed (i.e. the addition of a natural repellent).

Science as Inquiry Standards

Grades K-4

Abilities necessary to do scientific inquiry

- *Ask a question about objects, organisms, and events in the environment.*
- *Plan and Conduct a simple investigation.*
- *Employ simple equipment and tools to gather data and extend the senses.*
- *Use data to construct a reasonable explanation.*
- *Communicate investigations and explanations.*

Understanding about scientific inquiry

- *Scientific investigations involve asking and answering a question and comparing the answer with what scientists already know about the world.*



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Students design and implement a scientific investigation, including all steps of the scientific method and graphing the data they collect.

Grades 5-8

Abilities necessary to do scientific inquiry

- *Identify questions that can be answered through scientific investigations.*
- *Design and conduct a scientific investigation.*
- *Use appropriate tools and techniques to gather, analyze, and interpret data.*
- *Develop descriptions, explanations, predictions, and models using evidence.*
- *Think critically and logically to make the relationships between evidence and explanations.*
- *Recognize and analyze alternative explanations and predictions.*
- *Communicate scientific procedures and explanations.*

Use mathematics in all aspects of scientific inquiry.

- *Understandings about scientific inquiry*
- *Mathematics is important in all aspects of scientific inquiry.*

Students design and implement a scientific investigation, including all steps of the scientific method and graphing the date they collect.