Mission Folder: View Mission for 'Lanikai Science Squad'

State	Hawaii
Grade	7th
Mission Challenge	Environment
Method	Scientific Inquiry using Scientific Practices
Students	

Team Collaboration

(1) Describe the plan your team used to complete your Mission Folder. Be sure to explain the role of each team member and how you shared and assigned responsibilities. Describe your team's process to ensure that assignments were completed on time and deadlines were met.

The Lanikai Science Squad team members are Emma, Lily, Jasmine, and myself, Heather. We are friends from elementary school and competed in Ecybermission last school year in the 6th grade. We decided to form a 7th grade team because we felt strongly about helping our community reduce poisonous chemicals in our food and water. If we continued the science experiment on organic pest control using neem oil, we could continue to spread the message, "Don't Panic, Grow Organic!" This Ecybermission project is not required or supervised by our schools, and our Team Advisor is my mother. We are conducting all of the research and experiment after our school work is completed. (See attached Team Action Plan)

Emma and I are the senior team members because we were on the 6th grade team called "Basil Cello Scientists" conducting the original science project on organic pesticide. After one of the previous team members moved to Singapore, we invited Jasmine and Lily to join the 7th grade team as junior members. It was agreed that if there was a conflict, the senior members would make the final decision regarding the experiment. (See attached Team Responsibilities)

Emma attends a private school while the remainder of the team attends a nearby public intermediate school, but we all live near each other. We communicate about meeting dates and assignment by group text. Our Team Advisor communicates with our parents through emails. We have meetings once to twice a month, held at my house with my mother supervising the safety of the experiment. The plants are growing in our front yard, and we all work on the Mission Folder at our dining table using computers and printer. We each have a folder to keep our research and meeting notes. I manage the 3-ring binder with divider tabs to organize our interviews, data collection, and research.

We each volunteered for assignments we knew needed to be completed to progress on this science project. If someone could not complete an assignment on time, they would ask for help in the group text, and another team member was able to help out. Each team member is a very responsible honors student. We each drafted our work in Google Drive shared folders so each team member could comment, edit, and approve before we placed our answers in the Mission Folder. (See attached Experiment Schedule)

Emma McDonald is a 7th grade honors student at Punahou School in Honolulu, where President Obama graduated from high school. Emma is in the Speech Club, where she sharpens her public speaking skills, and this helped our science team during presentations, and while interviewing farmers and an expert on neem. It was also helpful that Emma speaks Chinese because some of the farm workers only speak Chinese. Emma is an analyst for this science team and helped analyze the data collected from growing the kale, rosemary, and cilantro. Emma is also a tech wiz, and she helps the team use technology to create tables and graphs from that data. Emma encourages the team to persevere and do the best they can by being a good role model leader. Also, Emma is not afraid of worms, so she was in charge of the secondary experiment of spraying pesticides on worms and observing their behavior for a week. Her hobbies include playing the cello and competing on the swim team. Having travelled to Taiwan and Canada numerous times gives Emma a broader perspective of worldly issues like pesticides use in different countries.

I, Heather, am a 4.0 GPA honor student in the 7th grade. I was the 6th grade class Spelling-Bee champion, and my spelling skills help our team when proofreading over our answers, catching small errors. My 6th grade science project on photosynthesis advanced to State competition. I was one of the top 3 finalist in the kids cooking contest for the Hawaii Food & Wine Festival. When we get tired and distracted from our work, I like to cook up something delicious like grilled cheese sandwiches, which gets us right back on track. I am artistic and designed the logo for our team shirts and folders. I also play the cello and will be performing in the 2017 Strings Solo & Ensemble Festival. I am an analyst for our team and do my best to produce good work.

Lily is a 4.0 GPA honors student in the 7th grade. She is very athletic, and she has made it National Cross Country and National Track & Field tournaments. She also advanced to the District Science Fair in 6th grade, so she has experience with scientific work. Lily is very intelligent and has achieved many different academic challenges. She has made it to state competition in Junior Lego League Robotics. She also made honor roll every year when she was in elementary school and she aspires to continue this. Lily is a great member of this team because she always finishes her assignments on time and goes above and beyond the minimum. This helps inspire and encourage the other team members to get their assignments completed to keep up with her. Lily's quick instincts make her a quick thinker, and a good problem solver. She is also a great communicator, and this helped our team while interviewing the neem expert because she makes sure her voice is heard whenever she speaks her opinion. She has participated in the speech festival for many years and has won several awards. In 5th grade, she was vice president and has experience communicating with group members to help complete challenging tasks.

Jasmine is a 4.0 GPA honors student in the 7th grade. In the 4th, 5th and 6th grade, Jasmine was Spelling-Bee champion of her class and, in 5th grade, represented the school at the Regional spelling bee, finishing in 4th place. She has been a member of the student council every year since 4th grade as a class representative. Her team, which included Lily and Emma, won an award for Best Robot Design at the First Lego League State Competition.Competition in Robotics. Her science project on the relationship between rash guard color and sun protection allowed her to participate to the Hawaii State Science Fair in 6th grade. She has lived overseas and travelled to

countries in Europe, Asia and the Americas. Also, it's cool that she can speak French. She is a prolific writer and is very creative. Her skillss help our team with proofreading, taking notes, and communicating with groups. She enjoys singing, acting, dancing, volleyball, and drama, which helps her with her time management skills. She is a good team member that encourages others with her sharp science mind and her upbeat personality.

We are thankful for our family members for supporting us during this science project.

Uploaded Files:

- [View] **Team Action Plan** (By: feather808, 02/05/2017, .docx)

  Timeline for Lanikai Science Squad to complete our Mission Folder.
- [View] **Team Responsibilities** (By: feather808, 02/05/2017, .docx)

  Chart of Lanikai Science Squad responsibilities for each team member.
- [View] **Experiment Schedule** (By: feather808, 02/05/2017, .docx)

  Chart of Lanikai Science Squad schedule with due dates and member name for each task to complete.

Scientific Inquiry

Problem Statement

(1) What problem in your community did your team investigate? Why is this problem important to your community?

HOW DO WE STOP SYNTHETIC PESTICIDES FROM HARMING HUMANS?
The problem in our community that we are trying to solve is how do we stop synthetic pesticide from harming humans? Synthetic pesticide is used to keep the pests off crops, which help them grow better, but when those crops are consumed by humans, it can be hazardous to the person's health. Harmful effects of synthetic pesticide include cancer and allergic reactions. It can negatively affect the reproductive system, nervous system endocrine system, and immune system.

In Hawaii, farmland accounts for 27% of Hawaii's total land usage. Hawaii has 152 certified organic farm operations, which is only 2% of the 7,500 farms. That means 98% or 7,348 farm operations in Hawaii are spraying toxic synthetic pesticides on our food, and that runs off to our soil and water. This is an important and serious problem that we are trying to help solve.

(2) List at least 10 resources you used to complete your research (e.g., websites, professional journals, periodicals, subject matter experts). Use multiple types of resources and do not limit yourself to only websites.

See the attached Resources for a list of resources used by Lanikai Science Squad research and grouped by category.

See the attached Bibliography for a complete alphabetical list of all resources used by Lanikai Science Squad to complete this Mission Folder.

Ecybermission Rule 7 - 3.a. If the work is a continuation of a previous year's project or the same topic, the Mission Folder from the previous year must be attached to this year's Mission Folder.
Please see the attached 6th Grade Mission Folder 2015-2016 by the Basil Cello Scientists on organic pesticide. This is to document significant new research, experiment, and results were conducted after April 1, 2016.

(3) Describe what you learned in your research.

RESEARCH ON NEEM
The book "Neem, A Tree For Solving Global Problems" is a 1992 report by a panel of scientists on the Board of Science and Technology for International Development, National Research Center. These scientists concluded that neem is a fascinating tree that has the potential to eventually benefit every person on Earth. It yields varied products that include pest control, medicine, and birth control.

In India, the 18 million neem trees (Azadirachta indica) are used to clean teeth, helped skin disorders, relieve pain, infections and fevers, and keep bugs away from the plants on farms. The neem tree grows tall in hot climate and spreads it leaves wide to provide shade relief. It has fruit that looks like a large olive. The seeds or leaves are crushed and steeped in water, and applied to plants to keep insects from damaging the crops. The neem tree grows quickly and requires little maintenance.

Extracts from the neem's fruit seeds (almond like kernels) and leaves are the ideal insecticide: it attacks many types of pest species; it does not harm people, animals, or beneficial insects; biodegradeable; it is a potent pest control; and insects are not able to build up a genetic resistance to neem.

It was fascinating to learn how neem works. The neem compounds do not kill the insects immediately, but they alter an insect's behavior or life processes. It leaves the pests alive but repelled, debilitated, or hormonally disrupted so that crops, people, and animals are protected. Eventually, the insect can no longer feed, breed, or metamorphose, and they die so they cannot cause further damage to the farm.

Neem contains several active ingredients that are not similar to the chemicals in synthetic pesticides. Chemically, neem is a distant relative of steroidal compounds, cortisone, birth-control pills, and many valuable pharmaceuticals. It is composed only of carbon, hydrogen, and oxygen. Neem has no atoms that are in synthetic pesticides such as chlorine, phosphorus, sulfur, or nitrogen.

A main component of neem called azadirachtin disrupts the metamorphosis of insect larvae, which then does not develop into pupae, and they die before reproducing. So bugs would rather starve to death than eat plant leaves that have neem on them.

Scientific studies conclude that neem pesticide is effective and affects insects dramatically, and showed results as good as those of standard pesticides. Even tiny amounts disrupt the life cycle of more than 200 pest species like locust, potato beetle, grasshopper, gypsy moth. Crops protected include wheat, barley, rice, sugarcane, tomatoes, cotton and chrysanthemums.

An important quality is that neem products appear to have little or no toxicity to warm blooded animals. It is safe to mammals including people. In India, people have added neem leaves to their grain stored for centuries to keep bugs away. So millions of people have been eating neem on a daily basis for generations.

Neem products actually benefit human health as an antiseptic, antiviral, antifungal, anti-inflammatory, hypotensive, and anti-ulcer effects. Materials from the seeds have contraceptive properties and could help with controlling population growth.

As the world population increases, demand for greater amount of quality food will increase. The farmers must grow more food that is not damaged by pests. Also, the public becomes more knowledgeable about the health dangers of chemicals in synthetic pesticides and insist on eliminating the poison from their food. Neem is the key to safer

pest control products and helping our environment. (Neem, A Tree, 1992)

The information in this book on neem was fascinating but it was printed in 1992. In the list of contributors to this study, we noticed that Dr. Saleem Ahmed was from Honolulu, Hawaii and worked at the University of Hawaii's East-West Center. We were able to contact him and he granted our team an interview at the Aloha Aina Nursery in Honolulu, Hawaii.

10/15/16, Interview with Dr. Saleem Ahmed, Ph.D. Agriculture, expert on neem trees at the Aloha Aina Nursery in Honolulu, Hawaii (see attached Photo--Research, Photos 11 and 12):
1. How does neem work on insects?
Neem acts in about four different ways. It acts like a poison after the insect eats it and dies. It acts like a repellant by making bugs go away. It acts like an attractant to pests who then ingests the neem on the plant and the pest dies. Neem has a hormonal action on pests who eat the neem and will not die right away, but flies to the nest and then slowly dies.

2. Is neem safe to ingest by humans?
Yes. I eat neem leaves regularly for diabetes. Very bitter, though. I am 76 years old and do not have a cavity. Neem is bad for insects but good for humans, cats, dogs. If you apply neem to standing water, mosquitos will not nest.

3. Will neem be FDA approved?
Yes, several neem-based products on the market contain azadirachtrin, one of the many active ingredients in neem. Neem by itself cannot be FDA-approved because it is not one chemical, but many. So each chemical has to be approved separately.

4. Are scientists currently conducting safety tests on neem like in Appendix A of the book?
Yes, in many labs around the world, including FDA.

5. How do you pronounce the word Azadirachta?
"Azad dirakht". It is the name West Asian conquerors of India (Moghuls and others) gave admiringly to the tree because of its numerous wonderful properties. Azad dirakht means "independent tree", or "free tree". I guess they meant a tree which has many good properties.

6. How do you obtain the neem oil from the trees?
By drying its grape-sized fruit and then pressing oil out. In India there are neem expelling factories to dry the fruit, remove the skin, and press the seed to obtain the oil.

7. How long does it take to grow a neem tree from seeds?
In about 3-4 years it can become 3-4 feet tall. It is a process in about 5 years it will have fruit. The tree brought to Lanikai park was about 5 years old and it is almost 30 feet tall.

8. Do you need to use pesticide on the growing neem plants or does it naturally deter insects from eating its leaves?
I have never used any pesticide on neem trees. Once in awhile I see an insect hole. But 1 or 2 neem seedlings out of 20-50 might die. I have not yet been able to figure out why. Wood from neem trees make good houses that do not get infested with termites.

9. The team's home made recipe/formula consists of neem oil, garlic, and Hawaiian chili peppers. Do you think the other two ingredients help the neem as a pesticide?
I don't know. But it is always good to experiment. (Ahmed, 2016)

Dr. Ahmed kindly gave our team another book about Neem, by Dr. Sheila Haas:
In 2009, the U.S. Environmental Protection Agency registered 100% cold-pressed neem oil as a pesticide, which contains azadirachtin, the most important compound for repelling insects. It noted its safety based upon thousands of years of continuous use in tropical countries. Neem is a cost effective and non-toxic alternative to chemical pest control in gardens and in agricultural settings. (Haas, Neem)

Neem is a cost effective and non-toxic alternative to chemical pest control in gardens and in agricultural settings. Please see attached Table 14 titled Neem's Low Relative Toxicity. This table shows how neem is much safer than Sevin because it takes much more neem (18 ounces) to kill half of the animals than it takes Sevin (0.6 ounces) to kill half the animals. (Haas, Neem)

FARMS AND PLANTS IN HAWAII
In Hawaii, farmland accounts for 27% of Hawaii's total land usage, and there are 7,500 farms in Hawaii. Hawaii has 152 certified organic farm operations. That means 7,348 farm operations in Hawaii are spraying toxic synthetic pesticides on their crops. (A Look At Hawaii Agriculture, 2010)

(See attached Photos--Research.) For background research, our team took an excursion to Leilani Nursery in Waimanalo, Hawaii to interview the president, Mr. Bill Durston (see Photo 9). This is where we obtained our organic kale and cilantro seedlings for our experiment. Leilani Nursery has an organic farm section with large white barrier separating it from the non-organic farm section. Mr. Durston said organic pesticides are much safer, but weaker and shorter lasting than synthetic pesticides. He purchases his organic pesticide from Pacific Ag or BEI, and does not make any of his own, and he applies it twice a month by sprayer. He said organic pesticide does not work as well as synthetic pesticide, and he sells less organic plants than non-organic plants to hardware and other retail stores in Hawaii. Organic vegetables are about +/-25% higher in cost than non-organic vegetables. (Durston, 2016)

The IUCN World Conservation Congress was hosted by Hawaii in September 2016. This is the largest conservation event in the world, and this was the first time in 60 years it was held in the U.S. We were proud to wear our Lanikai Science Squad team shirts and attend the Exhibition on September 3, 2016. We visited numerous booths sponsored by NASA, Google, US AID, Forest Pavilion, U.S. Dept of Agriculture, Nature Conservancy, Protected Planet, Sierra Club, and animal preservation. At the National Tropical Botanical Garden booth, we interviewed Dr. Uromi Goodale, a botanist with a Ph.D. in Plant Ecophysiology from Yale University (see Photo 10). She explained that neem has numerous medicinal purposes like soap, pesticide, cures fungal infections. For example, neem leaves are placed in the bath for newborn babies to be cleansed for the first time. As far as she knows, neem is not used in food because it has a bitter taste of alkaline, and our palate is sensitive to bitterness. She thinks our cilantro is dying because its soft tissue leaves reacted to the heat of the sun or from the Hawaiian chili peppers, and she recommended we dilute the concentration of our homemade organic pest control formula for the cilantro. She said rosemary has a tougher leaf surface. (Goodale, 2016)

A 12/15/2016 newspaper article in the Honolulu Star Advertiser reported that Hawaii will begin implementing a program that requires biotech companies to report pesticide use monthly, notify neighbors when spraying is happening and create buffer zones between farms and residents. Also, surface water will be sampled for pesticide before and during storms to evaluate whether pesticides are on the move and at what level. This new program was created because three years ago people of Kauai protested to the government about harmful pesticide spraying in their community. (Hurley, 2016)

HARMFUL EFFECTS OF SYNTHETIC PESTICIDE

Hawaii Center For Food Safety's key findings on pesticide use in Hawaii state Restricted Use Pesticides (RUP) sales data for Kauai show 22 RUPs containing 18 active ingredients were applied in agriculture from 2010 to 2012. The American Academy of Pediatrics report state their chief concern were that pesticides are linked to childhood cancers, neurobehavioral and cognitive deficits, adverse birth outcomes, and asthma. (Report Pesticides in Paradise, 2015)

Synthetic pesticide can cause three types of effects. Acute effects, which are effects that come right after the pesticide is present. Delayed effects, which don't show immediately (cancer). Allergic effects, are effects that not everyone has a reaction to. Synthetic Pesticide mainly affects the reproductive system, nervous system, endocrine system, and immune system. Some critical synthetic pesticides have been banned from the U.S., but is still used in other places even though they cause a serious health risk for children, bald eagles, and the environment. (Chien, UCSD)

There are four types of chemicals classes in synthetic pesticides. Organochlorines, organophosphates, pyrethroids, and carbamates are the four types of chemical classes in synthetic pesticides. (DeAngelis, 2004)

Personal interview with Mr. Christian Zuckerman of Kahumana Farms, a non-profit organic farm in Waianae, Hawaii (see attached Photo 8). We initially interviewed Mr. Zuckerman at the start of our research for our 6th grade experiment on basil, and he taught us how to make our own organic pesticide from garlic, Hawaiian chili peppers, and neem. We discussed the seriousness of the health issues and environmental impacts of chemicals in pesticides. They end up drifting in the air and killing good insects too. The chemicals sink into the soil and gets into our drinking water. In our follow-up interview with Mr. Zuckerman for our 7th grade experiment, he said their kalo plant leaves also burnt after applying the pest control. He agrees rosemary is a hardier crop that would not be affected by chilipepper or neem oil. He pointed out that most organic processes revolve around pest management and control. (Zuckerman, 2016)

A 1/3/2017 news article on CNN reported 4 children in Texas were killed by accidental pesticide poisoning. A resident applied pesticide under their mobile home that made them feel sick. To dilute it, a resident applied water to the aluminum phosphide that creates toxic phosphine gas, which caused excess fluid in the lungs and respiratory failure. The Food and Agriculture Organization of the United Nations said an estimated 1 to 5 million cases of pesticide poisoning occur every year, resulting in several thousand fatalities among agriculture workers. (Yan, 2017)

HEALTHY VEGETABLES

Dark green vegetables are better for you. Vegetables are green because they contain chlorophyll, which is the dark green pigment which allows leaves to use the sun to make food. Dark green vegetables are healthier because they contain less water and more chlorophyll. Kale and spinach have more chlorophyll than lighter greens like lettuce or cabbage. This gives kale and spinach a stronger taste and makes them better for you because they contain vitamins, minerals and other nutrients that keep you healthy. Those chemicals help with eye health, lower cholesterol and reduce your risk of getting certain cancers. Green leafy vegetables are good sources of nutrients that help to protect us from disease. They keep us healthy because green vegetables are rich in vitamin C, folates, carotenoids, vitamin K, and calcium, and may also provide small amounts of iron. (Light Greens vs Dark, 2011)

Fresh leaves from the rosemary herb should feature deep green leaves, free from spots or yellowing. Rosemary herb carry very good amounts of vitamin A which is known to have antioxidant properties and is essential for vision. It is also required for maintaining healthy mucosa and skin. Consumption of natural foods rich in vitamin A is known to help the body protect from lung and oral cavity cancers. Rosemary herb parts are rich source of minerals like potassium, calcium, iron, manganese, copper, and magnesium. Potassium is an important component of cell and body fluids, which helps control heart rate and blood pressure. (Rudrappa, 2009)
During photosynthesis, chlorophyll is a plant pigment that absorbs light and creates energy. Chlorophyll helps block cancer, helps in normal blood clotting, wound healing, hormonal balance, deodorizing and detoxification of the body and promotes digestive health. It has healing effects on oxidation and inflammatory conditions such as arthritis and fibromyalgia. (Axe, 2016)

COMMUNITY BENEFIT

Follow-up interview with Ms. Kellie Gutheil-Lee, expert on organic farming, and Farm Coordinator of Herbco International in Waianae, Hawaii. Ms. Gutheil-Lee provided valuable wholesale cost for our analysis in comparing cost of organic vs synthetic pesticide. She provided wholesale cost for our analysis in comparing retail and whole prices prices of organic vs non-organic vegetables and herbs. This information is in the Community Benefit section of our Mission Folder. (Gutheil-Lee, 2017)

On 5/14/2016 the Honolulu Star Advertiser newspaper reported that Hawaii is poised to be first to aid farmers' organic certification. Hawaii became the first state to pass legislation providing tax breaks to farmers to offset the cost of getting certified as organic by the U.S. Dept. of Agriculture. In Hawaii, the legislation would give farmers up to $50,000 in tax credits for qualifying expenses, which include application fees, inspection costs and equipment or supplies needed to produce organic products. Cost of getting certified ranges from few hundred dollars to few thousand dollars according to USDA. (Bussewitz, 2016) This newspaper article said state Representative Chris Lee introduced this bill. Since he represents our town, we contacted him and he granted us an interview.

On 2/13/2017, we conducted a telephone interview of Hawaii Representative Chris Lee of the Kailua and Waimanalo district. The purpose of this Act was to encourage more farmers to convert to organic farming. Farmers receive the $50,000 tax credit if they are in the business of organic food production. Big land owners opposed this bill. More information from this interview is in the Community Benefit section of our Mission Folder. (Lee, 2017)

On 10/9/2016 the Honolulu Star Advertiser newspaper summarized the results of the World Conservation Congress hosted in Hawaii. Regarding the category of Food Security, a goal is to increase local food. We need to have a robust agricultural industry to support local food production. Agribusiness opportunities as a value-added industry involves re-educating the youth of Hawaii to drive this new system. The restaurants and grocery stores want local products because the customers will pay a premium for it. There is value-add there economically and they are willing to pay for it. (Tangonan, 2016)

ORGANIC PEST CONTROL IS SAFER FOR HUMANS AND ENVIRONMENT

Slugs, snails, and caterpillars can damage lush green foliage leaving behind crinkle edged holes. The use of simple organic pesticides and fungicides can be an acceptable form of organic gardening. Most of nature's chemicals are biodegradable. Some commonly acceptable organic pesticides are garlic, chili pepper, neem oil, and soap. (Fedor, 2001)

Hypothesis

(4) State your hypothesis. Describe how your hypothesis could help investigate your problem.

If farmers stop using synthetic pesticide and switch to homemade organic pest control at a reasonable cost, then the produce will not be destroyed by pests and they will grow just as well in size and shape because organic pest control works just as well, if not better than synthetic pesticide without the toxic chemicals in the vast amount of synthetic pesticide being used in Hawaii's environment.

(5) Identify the independent variables and the dependent variables in your hypothesis.

For the primary experiment, the independent variable will be the different kinds of pesticides sprayed on the plants -- organic and synthetic. The dependent variable will be the plants -- how much they grow and how many bugs on them. The control group will be the 3 plants that are left in their natural state, which is with no pesticide.

For the secondary experiment, the independent variable will be the different pesticides sprayed on the worms and crickets -- organic and synthetic. The dependent variable will be the effect on the worms and crickets. We will observe how the worms and crickets react to the pesticides and how many days they survive.

(6) When you developed your hypothesis how did you know it could be tested AND could be proven false by testing?

When we developed our hypothesis, we knew that it could be tested and proven true or false because in our experiment process if our hypothesis was false, then the plants that were treated with organic pest control would have been damaged by pests and the growth would be affected negatively compared to plants treated with synthetic or no pesticide.

Using a ruler to measure height and width of plants and by counting bugs and holes in leaves, we are able to measure the validity of our hypothesis that plants sprayed with organic pest control will not have pests destroying them, and the plants will grow just as well as the plants sprayed with synthetic pesticide.

Furthermore, we conducted the experiment for 6 weeks to allow ample time for the independent variables (pesticides) to have an affect on the plants. Data was collected from 3 trials of each of the 3 groups of plants -- organic pest control, synthetic pesticide, and no pesticide. We arranged 3 trials for 3 groups for each of the 3 plant types -- kale, cilantro, and rosemary. We believe this was sufficient data to obtain accurate results.

Experimental Design

(7) List the materials you used in your experiment. Include technologies you used (e.g., scientific equipment, internet resources, computer programs, multimedia, etc.).

MATERIALS TO GROW PLANTS -- KALE, CILANTRO, ROSEMARY
organic soil
organic fertilizer
water
9 organic kale seedling plants
9 organic cilantro seedling plants
9 organic rosemary seedling plants
6 garden boxes 28”long x 12”wide x 10”deep
garden hand spade tool
27 plastic plant markers/signs
3 yardsticks
mini moisture tester for soil
chart paper to record measurements
pen
black sharpie pen
camera

MATERIALS TO MAKE ORGANIC PESTICIDE
neem oil
organic Hawaiian chili peppers
organic garlic
warm water
knife
cutting board
measuring spoon
measuring cup
spoon
blender
strainer
empty spray bottle
black sharpie pen
face mask
plastic gloves
large black trash bags
spray bottle of synthetic chemical pesticide
chart paper to record observations
pen
camera

MATERIALS TO TEST THE EFFECT OF PESTICIDE ON WORMS AND CRICKETS
batch of our homemade organic pest control in spray bottle
spray bottle of synthetic chemical pesticide
meals worms
crickets
6 plastic containers with clear lids
watch timer
sewing pin to punch tiny holes in plastic cover so worms and crickets can breathe
black sharpie pen
chart paper to record observations
pen
camera

MATERIALS TO CAPTURE AND IDENTIFY PESTS ON KALE, CILANTRO, ROSEMARY
small zip lock bags

microscope
magnifying glass
chart paper to record our observations
pen
camera

TECHNOLOGY USED
computer internet, Google Earth, Bibme.org,
computer scanner, printer, copier
computer Google Drive, Google Docs, Google Sheets
Microsoft Word Drawing Tools for charts
Apple Numbers for pie chart
Photoshop software

MATERIALS FOR PRESENTATIONS
poster board
print out of charts, graphs, photos, results, formula
scissors and paper cutter
glue sticks
10 folder booklets
black sharpie pen
10 small empty spray bottles
batch of our homemade organic pest control
small printouts of our Lanikai Science Squad logo

(8) Identify the control group and the constants in your experiment.

PRIMARY EXPERIMENT: SPRAYING ORGANIC AND SYNTHETIC PESTICIDES ON PLANTS -- KALE, CILANTRO, ROSEMARY
Control group: Three kale plants, three cilantro plants, and three rosemary plants in the same garden box are left in their natural state, which is with no pesticide sprayed on them.

Constants:
the 9 kale plants are all the same type called curly kale
the 9 cilantro plants are the same
the 9 rosemary plants are the same
the 9 kale seedling plants are starting the experiment at about the same size in height, width, leaves without holes or tears, and no bugs
the 9 cilantro seedling plants are starting the experiment at about the same size in height, width, leaves without holes or tears, and no bugs
the 9 rosemary seedling plants are starting the experiment at about the same size in height, width, leaves without holes or tears, and no bugs
size of the 6 garden boxes are exactly the same and 3 plants were planted in each garden box
amount of organic soil in each garden box is the same
amount of organic fertilizer in each garden box is the same
amount of water given at the same time
amount of rain water received
amount of exposure to sunlight was equal
temperature, wind and humidity were equal
exposure to pests day and night was equal
time duration of 6 weeks to grow and react to pesticide
yardsticks to measure plants accurately were standard

SECONDARY EXPERIMENT: SPRAYING ORGANIC AND SYNTHETIC PESTICIDE ON WORMS AND CRICKETS
Control group: Thirty-four worms in a plastic container and 12 pinsize airholes are left in their natural state, which is with no pesticide sprayed on them.
Twenty crickets in a plastic container and 12 pinsize airholes are left in their natural state, which is with no pesticide sprayed on them.

Constants:
all meal worms were from the same pet store
all crickets were from the same pet store
plastic containers were the same
temperature, wind, and humidity were the same
after spraying pesticide separately, the 3 containers were placed next to each other
time duration of 6 days for all worms and crickets to react to pesticide

(9) What was your experimental process? Include each of the steps in your experiment. Include all safety precautions used by your team as step one.

EXPERIMENTAL PROCESS (See attached Photos -- Experiment)

SAFETY PRECAUTIONS
When at the farms, we wore toe-covered shoes, and only walked with the farmers. There was an adult supervising us while preparing the organic pest control formula and when applying the pesticides to the plants. When applying pesticide, we wore plastic gloves, face masks, and held up plastic bags as a blocking divider between the garden boxes so the pesticide did not drift to the other plants. We were careful in storing the pesticide and our gardening tools in the garage.

PRIMARY EXPERIMENT: SPRAYING ORGANIC AND SYNTHETIC PESTICIDE ON PLANTS -- KALE, CILANTRO, ROSEMARY
PLANTING SEEDLINGS (See attached Photo 15)
1. Place 3 garden boxes about 6 inches apartment in a sunny location. The box on the right is the experiment group using organic pesticide. The box in the middle is the experiment group using synthetic pesticide. The box on the left is the control group with no pesticide. We will conduct 3 trials of the experiment by placing 3 separate kale plants in each garden box.
2. Put organic soil to fill each garden box about ? full.
3. Use a garden hand spade tool to dig 3 holes in the soil of the left hand side of each of the 3 garden boxes.
4. Plant 9 organic kale seedling in each of the 3 holes in the 3 separate garden boxes.
5. Put organic fertilizer about 4 inches wide over the soil on the right side of each of the 3 garden boxes.

6. Cover the holes with soil and pat the soil down gently around the kale seedling plant.
7. Water the kale plants till the soil is moist and water every 3 days.
8. We named each plant so they can be easily identified. We wrote the name of each plant and which group they are in (organic, synthetic, control) on a plant sign and placed it in the soil next to the designated plant.
9. On graph paper, we created a chart listing the plant names, group, dates of observations, height and width measurements, pest count, count of holes in leaves, soil moisture reading, and observation notes. This became our data tables.
10. Right after we planted the kale seedlings, we noted on our data chart the initial measurements of the plants' height, width, number of pests, holes in leaves, soil moisture reading, and observations.
11. Repeat steps 1-10 with cilantro.
12. In 3 weeks the cilantro plants died, so we repeated steps 1-10 with rosemary seedlings. (See attached Photo 18)

MAKING ORGANIC PEST CONTROL (See attached Photo 13)
1. In a blender, add 2 cups of warm water.
2. Add ½ teaspoon of neem oil.
3. Chop 2 tablespoons of garlic and add to blender.
3. Chop 1 tablespoon of Hawaiian chili peppers and add to blender.
4. Blend until smooth liquid.
5. Use a strainer to pour liquid from the blender into a spray bottle.
6. Trash the clumps and seeds remaining.

SPRAYING ORGANIC AND SYNTHETIC PESTICIDE ON PLANTS (See attached Photo 14)
1. At the local hardware store, we purchased a spray bottle of synthetic pesticide called "Sevin". Once a week, we sprayed this synthetic pesticide on the middle garden box of kale, cilantro, and rosemary plants. We sprayed from the top of the leaves and underneath the leaves while holding up plastic bags as a blocking divider between the garden boxes so the pesticide would not drift to the other plants.
2. Once a week for 6 consecutive weeks, we sprayed our homemade organic pest control on the right garden box of kale, cilantro, and rosemary plants. We sprayed from the top of the leaves and underneath the leaves.
3. We did not spray pesticide on the left garden box of kale, cilantro, and rosemary plants.

GATHERING DATA ON THE KALE, CILANTRO, AND ROSEMARY PLANTS' HEIGHT, WIDTH, PESTS, SOIL.
1. Using a yardstick ruler every 2 weeks, we collected data on the kale, cilantro, and rosemary plants' height and width measurements. We measured from the tip of the leaves of the highest point of the plants to the soil for the height.
2. We measured the tip of the leaves from side to side at the widest point of each plant for the width. We were consistent with accurate measurements taken very carefully.
3. We carefully observed and counted the number of pests on each plant. We also looked under the leaves and on the stems.
4. We counted the number of holes on leaves on each plant.
5. We tested the amount of moisture in the soil in each garden box using a mini moisture tester.
6. We immediately recorded the data on the charts we made. We also took photos to document the condition of each plant.
7. Using a small zip lock bag, we scooped in close to capture tiny insects, probably ants, on the control cilantro plant. We observed the insects under a microscope. (See attached Photo 6)

GATHERING DATA ON KALE, CILANTRO, AND ROSEMARY PLANTS' LEAF COLOR AFTER 6 WEEKS OF APPLYING PESTICIDE
1. Using a microscope and magnifying glass, we observed the color and texture of the leaves of the kale, cilantro, and rosemary plants. (See attached Photo 7)
2. Using Photoshop software, we measured the RGB color test on leaves of kale and rosemary plants.

SECONDARY EXPERIMENT: THE EFFECT OF PESTICIDES ON WORMS AND CRICKETS
(See attached Photos 16)
1. Remove the clear plastic lids of three plastic containers and use a sewing pin to poke 12 pin size air holes in the covers.
2. Label each cover with a black sharpie pen the type of pesticide that will be used -- organic, synthetic, or none.
3. Place 34 meal worms in each container.
4. Move the container labeled synthetic away from the others and spray 5 squirts of the synthetic pesticide "Sevin" on the worms. Replace the cover.
5. Move the container labeled organic away from the others and spray 5 squirts of our homemade organic pest control on the worms. Replace the cover.
6. In the container labeled none, do not spray anything on the worms. Replace the cover.
7. For the first 10 minutes, observe the effect of pesticides on the worms and take notes on our chart sheet.
8. Over the next 6 days, observe the effect of pesticides on the worms and take notes on our chart sheet.
9. Repeat steps 1-8 with crickets. (See attached Photo 17)

Data Collection and Analysis

(10) Present the data you collected and observed in your testing. The use of data tables, charts, and/or graph is encouraged.

Data was collected from 3 trials of each of the 3 groups of kale plants. Two groups were experimental (the organic pest control and synthetic pesticide) and one was the control group. We planted 3 organic kale plants in each of the 3 garden boxes. Once a week we sprayed organic pest control on three of the kale plants, synthetic pesticide on three of the control plants, and we left the other three kale plants with no pesticide to be the control group. Every two weeks, we measured the height and width of each kale plant to see if the pesticides affected the growth. At the same time, we also counted the number of pests we observed and the number of holes in the leaves on each of the kale plants. We also used a moisture meter tool to measure the amount of moisture in the soil of the 3 garden boxes. We repeated this process with cilantro and rosemary plants.

DATA COLLECTION ON KALE
See attached Plant Growth Tables 1-11. Table 1 has the measurements of the kale plants' height in inches. The average growth in height for the control group is the greatest at 5 3/4 inches. However, the average growth in height of 5 3/10 inches for the organic pest control group is greater than the average growth in height of 4 3/10 inches for the synthetic pesticide group. This means that the organic pest control kale grew to be taller than the synthetic pesticide kale.

See attached Plant Growth, Table 2 for the measurements of the kale plants' width in inches. The average growth in width for the control group is the greatest at 15 inches. The average growth in width of 10 2/25 inches for the synthetic group is greater than the average growth in width of 8 ¼ inches for the organic group.

See attached Plant Growth, Table 3 for number of bugs and holes in the leaves of kale plants. During the 6 weeks we conducted our experiment, we observed 1 bug on a synthetic pesticide kale during Week 5. By the end of the 6th week, there were 30+ holes in the leaves of 2 out of 3 kale plants sprayed with synthetic pesticide. The third kale plant sprayed with synthetic pesticide died during the 6th week. This means the synthetic pesticide did not eradicate the bugs. Only one controlled plant had 30+ holes in the leaves of the kale plants. The organic kale group had less than 30 holes in their leaves and no bugs present during the counting. This supports our hypothesis that the organic pest control helped exterminate the bugs.

See attached Plant Growth, Table 10 for the kale moisture meter readings. With this tool, 1 means dry and 5 means wet, and wet soil is better for the plants to be nourished by moisture. One of the kale plants sprayed with synthetic pesticide had the driest soil reading of 3 ¼ and two of the kale plants sprayed with organic pest control had the wettest soil reading of 5.

See the attached Photos--Data, Photo 4 shows that after 6 weeks of applying synthetic pesticide to the kale in the middle garden box and organic pest control to the box on the right and no pesticide to the control box on the left, the healthiest looking kale is in the organic box on the right.

See attached Photos--Data, Photo 3 shows kale plant “Fluffy” from the synthetic kale group. This kale has many holes in its leaves. The round shape of the holes is from slugs and snails that come out at night munching on the leaves. You can see a brown slug laying on the leaf. So not only did bugs eat the kale, but also snails and slugs.

DATA COLLECTION ON ROSEMARY
See attached Plant Growth, Table 4 for the measurements of the rosemary plants’ height in inches. The average growth in height for the control group is 0 inches, for the synthetic pesticide group is -? inches, and for the organic pest control group is 1 ¼ inches. The rosemary plants grew in height about the same for all three groups.

See attached Plant Growth, Table 5 for the measurements of the rosemary plants’ width in inches. The average growth in width for the control group is 1 ½ inches, for the synthetic pesticide group is 4 ? inches, and for the organic pest control group is 1 ? inches. The rosemary plants sprayed with synthetic pesticide grew wider than organic and control.

See attached Plant Growth, Table 6 for number of bugs and holes in leaves of the rosemary plants. During the 6 weeks we did our experiment, we saw 28 bugs on the control group of rosemary, 1 bug on a synthetic rosemary group, and 1 bug on the organic rosemary group. This means for the rosemary, organic pest control and synthetic pesticide were equally effective in eradicating the bugs.

See attached Plant Growth, Table 11 for rosemary moisture meter readings. With this tool, 1 means dry and 5 means wet, and wet soil is better for the plants to be nourished by moisture. One of the rosemary plants sprayed with synthetic pesticide had the driest soil reading of 2 and three of the rosemary plants sprayed with organic pest control had the wettest soil reading of 4.

See the attached Photos--Data, Photo 5 shows that after 6 weeks of applying synthetic pesticide to the rosemary in the middle garden box and organic pest control to the box on the right and no pesticide to the control box on the left, all the rosemary grew healthy except rosemary named Rose whose leaves were extremely light green because of the white film left by the synthetic pesticide.

See attached Photos--Data, Photo 7 of a team member using a magnifying glass to observe a rosemary leaf that has white dots from the chemicals in the synthetic pesticide.

DATA COLLECTION ON CILANTRO
See attached Plant Growth, Table 7 for the measurements of the cilantro plants’ height in inches. The average growth in height for the control group is 1 7/10 inches, for the synthetic group is also 1 7/10 inches, and for the organic group is slightly greatest at 1 9/10 inches. All of the groups grew about the same amount in height.

See attached Plant Growth, Table 8 for the measurements of the cilantro plants’ width in inches. The average growth in width for the control group is 2 7/10 inches, for the synthetic group is 2 2/25 inches, and for the organic group is 2 ? inches. All of the groups grew about the same amount in width.

See attached Plant Growth, Table 9 for number of bugs and holes in the leaves of the cilantro plants. During the 4 weeks the cilantro survived, we saw a total of 16 bugs on the third week for the controlled group and no bugs for the synthetic and organic group. This means for the cilantro, organic pest control and synthetic pesticide were equally effective in eradicating the bugs. On the fourth week most of the cilantro had died.

See attached Photos--Data, Photo 1 of cilantro plant named Bob from the synthetic pesticide group covered in white film which is believed to be caused by the chemicals in the synthetic pesticide.

See attached Photos--Data, Photo 2 of cilantro plant from the control group covered in tiny black bugs. See attached Photos--Data, Photo 6 of a team member using a microscope to observe, sketch, and identify the bug from the control cilantro plant as a black ant.

DATA COLLECTION ON THE EFFECT OF PESTICIDES ON WORMS
See attached Photos--Experiment, Photo 16 and Graph 1 for data on our secondary experiment of spraying organic and synthetic pesticide on worms. The organic pest control and synthetic pesticides both eventually killed the worms, but the results took various lengths of time to take effect. When sprayed with the organic pest control, there were no obvious indications of the worms dying right away as the first worms died about 1 day after the pest control was sprayed. The synthetic sprayed worms immediately started squirming around and piling on top of each other, and some died within 3 minutes of the spraying of the pesticide. All of the worms that had been sprayed with organic pest control died after 5 days, and all of the synthetic pesticide sprayed worms were dead 2 days after the spraying. The worms that were sprayed with nothing died after 7 days. This means that the synthetic pesticide killed the worms faster than the organic pest control.

DATA COLLECTION ON THE EFFECT OF PESTICIDES ON CRICKETS
See attached Photos--Experiment, Photo 17 and Graph 2 for data on our secondary experiment of spraying organic and synthetic pesticide on crickets. The organic and synthetic pesticides had mainly the same effect on the crickets, but at different lengths of time. The crickets that were sprayed with 5 squirts of organic pest control died in 6 days, but at first began to freak out and immediately went crazy and were in a panic frenzy state. The crickets that were sprayed with 5 squirts of synthetic pesticide died in the first 10 minutes, and their immediate reaction was freaking out, and they were fighting amongst themselves and jumping trying to escape. The crickets that were sprayed with nothing died after 3 days. This is pretty odd because the control died before the organic pest control.

DATA COLLECTED ON THE COLOR OF LEAVES
See attached Table 12 and Graph 3 on the RGB color test using Photoshop software on kale plants. Kale leaves sprayed with organic pest control had the lowest integer values, which means it was the darkest shade of green. Our research on vegetables showed dark green vegetables are healthier because they contain less water and more chlorophyll, which contains vitamins, minerals, and other nutrients.

See attached Table 13 and Graph 4 on RGB color test with Photoshop software on rosemary. Rosemary leaves sprayed with organic pest control had an integer value closer in color to the rosemary leaves with no pesticide sprayed on them. However, the rosemary with the synthetic pesticide sprayed on them had the lowest integer value, which means it was the darkest shade of green, even darker than the control rosemary.

(11) Analyze the data you collected and observed in your testing. Does your data support or refute your hypothesis? Do not answer with a yes or no. Explain your answer using one of the following prompts: 'Our data supports/refutes the hypothesis because...'

Our data supports our hypothesis because it showed the following:

1. The kale and rosemary plants treated with the organic pest control protected the plants from being destroyed by pests.
2. The kale and rosemary plants treated with organic pest control grew just as well in size and shape as the kale and rosemary plants treated with synthetic pesticide.
3. The organic plants were healthier than the plants sprayed with synthetic pesticide. This was shown by the organic kale having darker green leaves, which means richer in chlorophyll, than the kale plants sprayed with synthetic pesticide. The rosemary treated with synthetic pesticide had a coat of white film on its leaves that were left by the chemicals in the synthetic pesticide.
4. It is logical to conclude that organic pest control is safer for people to spray on plants because it does not have the harmful toxic chemicals found in synthetic pesticide.

The organic kale plants had less bugs and less holes in their leaves caused by pests than the kale sprayed with synthetic pesticide.This shows that the organic pest control is in fact even more efficient at keeping pests away from plants than the synthetic pesticide we bought at the store.

We observed the organic kale grew larger and looked stronger than the kale sprayed with synthetic pesticide and about just as well as the kale with no pesticide. This shows that the homemade organic pesticide allows the plants to grow naturally like the control plants.

We observed the rosemary plants grew about the same for all three groups. The control group of rosemary had the most bugs. For the rosemary, organic pest control and synthetic pesticide were equally effective in eradicating the bugs.

The cilantro plants died within 4 weeks, but we observed that the cilantro plants sprayed with synthetic pesticide had a white coat of film on its leaves. This white film must have been the toxic chemicals that were being left on the plant and not naturally being washed off with the rain. We observed the leaves of the control cilantro had many black bugs that looked like ants on them.

The soil of the kale and rosemary garden boxes sprayed with organic pest control retained more water than the soil of the kale and rosemary garden boxes sprayed with synthetic pesticide. We think the chemicals in the synthetic pesticide dry out the soil and hinders the plants from processing moisture properly.

We measured the RGB of each of the plants using Photoshop software. RGB stands for red, green, and blue, and the lower integer values means the darker the color, and the higher integer values the lighter the color. The organic kale had the darkest green color according to our RGB measurements because the numbers were the smallest compared to the control and synthetic kale. This means it has more chlorophyll, therefore the organic kale is the healthiest because it is packed with rich vitamins and nutrients.

Using a microscope and a magnifying lens, we took a closer look at the cilantro and rosemary leaves that had a white film on them from being sprayed with synthetic pesticide. See attached Photo 7, we used a magnifying lense to see the white coating in more detail. The white spots were not growing from the leaves, they were a coating on top of the surface of the leaves.

The results of our secondary experiments of spraying organic and synthetic pesticide on worms and separately on crickets were very interesting. Observations confirmed synthetic pesticide is very toxic and kills pests the quickest. For the worms, the results were different than the exact test we conducted on worms last school year. Last year the worms sprayed with organic pest control lived 2 days longer than the worms that were not sprayed with anything. This year the worms sprayed with organic pest control lived 2 days less than the worms that were not sprayed with anything. We would like to repeat this experiment again in the future to validate the results.

Results of spraying pesticide on the crickets were also interesting. The crickets that were sprayed with organic pest control died in 6 days, but the crickets that were sprayed with nothing died in 3 days.This is pretty odd that the crickets without anything sprayed on them died before the crickets sprayed with organic pest control. We would like to repeat this experiment again in the future to validate the results.

(12) Explain any sources of error and how these could have affected your results.

Sources of error that could have affected our results when we measured the height of all the plants is that the soil could have shifted, making the plants seem taller or shorter than they actually were. This systematic error may have affected the measurements of the rosemary plants, and that would explain why some rosemary plants shrunk in height.

When we sprayed pesticide on the plants some random sources of error that may have affected our results is that we might not have applied the most effective amount of pest control or pesticide to the plants. We think the first batch of organic pest control contained too much chili peppers, and that may have burnt the leaves on our cilantro plants that died in four weeks. For the second batch of organic pest control, we adjusted the formula from 2 tablespoons of Hawaiian chili pepper to 1 tablespoon.

When we tested the effect of pesticides on worms and crickets, the spray bottles may be a source of error. Squirting 5 times may not have been full squirts and this changed the amount of pesticide applied on the worms and crickets.

Drawing Conclusions

(13) Interpret and evaluate your results and write a conclusion statement that includes the following: Describe what you would do if you wanted to retest or further test your hypothesis. Evaluate the usefulness of the data your team collected. What changes would you make to your hypothesis and/or experimental design in the future, if any?

Our experiment proved our hypothesis correct. Our experiment was a success because we proved that organic pest control works just as well as synthetic pesticide because it showed the following:

1. Applying the organic pest control on kale and rosemary plants kept them safe from the plant-eating bugs.
2. The organic pest control worked just as well as the synthetic pesticide in allowing the plants to grow in height and width with the natural ingredients instead of the harmful chemicals in synthetic pesticide.
3. The kale sprayed with organic pest control was shown to be healthier than the kale sprayed with synthetic pesticide because organic kale had darker green colored leaves. This means it is richer in chlorophyll that contains vitamins and nutrients, so organic kale is healthy for the human body.
4. It is logical to conclude that organic pest control is safer for people to spray on plants than the harmful synthetic pesticide because it does not contain the toxic chemicals found in synthetic pesticide. So organic pest control is better for humans, animals, and our environment.

To further test our hypothesis in comparing organic versus synthetic pesticide, we tested their effect on worms and crickets. Definitely the toxic chemicals in the synthetic pesticide are strong and effective in eradicating pests quickly, but the organic pest control also eradicated the worms and crickets about 3 to 5 days later.

Neem is the key ingredient providing a natural alternative to synthetic pesticides. Neem is not expensive, is easy to purchase, and only a small amount is needed to be effective. Our research on neem oil helped explain the effect of our organic pest control with neem oil on the worms and crickets:

The neem compounds do not kill the insects immediately, but they alter an insect’s behavior or life processes. It leaves the pests alive but repelled, debilitated, or hormonally disrupted so that crops, people, and animals are protected. Eventually, the insect can no longer feed, breed, or metamorphose, and they die so they cannot cause further damage to the farm. (Neem, A Tree For Solving Global Problems)

USEFULNESS OF DATA
The data we collected last year on basil and this year on kale, rosemary, and cilantro can be very useful to farmers. If the farmers evaluated our data with an open mind, it shows farmers should stop using synthetic pesticide and switch to homemade organic pest control with neem oil to prevent pests from damaging their plants. We will encourage farmers to switch to organic farming by distributing our sample bottles of homemade pest control with neem along with our booklet of data tables, graphs, and photos. It is very important to the health of our community for farmers to use organic pest control instead of synthetic pesticides with toxic chemicals that could have side effects of harming people, animals, and our air, soil and water.

FURTHER TEST THE HYPOTHESIS
In the future, using the same hypothesis, we could test different plants like spinach and strawberries. We could test with different amounts of the pesticides on the plants. Also, we could alter the formula for the homemade organic pest control by testing just neem or neem and garlic. We would like to retest the effect of different pesticides on worms and crickets to obtain more valid data.

CHANGES TO EXPERIMENTAL DESIGN
In the future, using the same hypothesis, our team could change the experiment by testing different locations to see if the same results will occur at the drier parts of the island of Oahu.
We had an idea to use time-lapse photography to observe the bugs reaction to neem.

CONCLUSION
We conclude that our hypothesis is correct that making organic pest control yourself is a less expensive method of eradicating pests from plants while allowing them to grow naturally and healthy. This experiment offers a valid solution of homemade organic pest control to the community problem of toxic chemicals in synthetic pesticide harming humans, animals, and our environment in Hawaii because it is an inexpensive yet effective alternative.

The results of this experiment are a step in the right direction for preserving our environment and leading to a more sustainable, healthy future for everyone.

Uploaded Files:

- [View] **6th Grade Mission Folder** (By: feather808, 02/05/2017, .pdf)
  6th grade Mission Folder for Basil Cello Scientist experiment with organic pesticide on basil plants.
- [View] **Table 14** (By: feather808, 02/05/2017, .jpg)
  Neem's Low Relative Toxicity
- [View] **Photos--Research** (By: Beaner, 02/05/2017, .pdf)
  Photos 8 - 12 of our interviews with experts.
- [View] **Photos--Experiment** (By: Beaner, 02/05/2017, .pdf)
  Photos 13 - 18 of our experiment process.
- [View] **Photos--Data** (By: lonelyslipper, 02/05/2017, .pdf)
  Photos 1 - 7 of data from our experiment.
- [View] **Plant Growths Table 1-11** (By: memma808, 02/05/2017, .pdf)
  Tables 1 - 11 of data collected over 6 weeks on our plants.
- [View] **Graph 1 and Graph 2** (By: Beaner, 02/05/2017, .pdf)
  Graph 1 Effects of Pesticide on Worms Graph 2 Effects of Pesticide on Crickets
- [View] **Table 12-13, Graph 3-4** (By: lonelyslipper, 02/05/2017, .pdf)
  Table 12 Kale RGB Color Test Table 13 Rosemary RGB Color Test Graph 3 Kale RGB Graph 4 Rosemary RGB
- [View] **Resources** (By: feather808, 02/14/2017, .pdf)
  List of resources grouped by category.
- [View] **Bibliography** (By: feather808, 02/14/2017, .pdf)
  List of resources in Bibliography format.

Community Benefit

(1) How could your experiments and data help solve your problem and benefit your community? Describe next steps for further research/experimentation and how you have or how you could implement your solution in the future.

OUR EXPERIMENT AND DATA CAN HELP SOLVE THE PROBLEM OF PESTICIDE POISONING
In Hawaiian, the word “aina” means our land. To protect our aina, we are trying to find a better alternative for synthetic pesticide by making our own organic pest control that farmers can use to grow their crops just as well or better than crops sprayed with synthetic pesticides.

We identified a community problem that 98% of the farms in Hawaii are using synthetic pesticide on their crops. Research has shown that the chemicals in synthetic pesticide can lead to serious health issues like cancer, diabetes, and birth defects. How do we stop synthetic pesticide from harming humans and our environment in Hawaii? DON’T PANIC, GROW ORGANIC!

Our experiment and data can help solve the community problem of pesticide poisoning because we found a low cost replacement for synthetic pesticide at $.13 per ounce -- homemade organic pest control with neem oil. Our experiment can significantly impact our community problem of pesticide poisoning because our data showed that organic pest control works just as well as synthetic pesticide in preventing pests from damaging the crops, grows well in size, and is better for your health with more chlorophyll. We believe homemade pest control made from organic materials is the solution, and it will not harm humans and our environment.

OUR EXPERIMENT AND DATA CAN BENEFIT OUR COMMUNITY
Using organic pest control is a benefit to our community of Hawaii because farmers can offer their customers food that will not lead to cancer or other illnesses associated with the toxic chemicals found in synthetic pesticide. Farmers can be proud that their produce is organic and healthy for the environment.

The data we collected last year on basil and this year on kale, rosemary, and cilantro can be very useful to farmers. If the farmers evaluated our data with an open mind, it shows farmers should stop using synthetic pesticide and switch to homemade organic pest control with neem oil to prevent pests from damaging their plants.

It will benefit the entire community of Hawaii if farmers stop using synthetic pesticides with chemicals and switched to organic pest control. First of all, the farmers and their families would not have to breath the toxic chemicals. Second, the people of Hawaii that are buying and eating those produce will be healthier by not ingesting the toxic chemicals that cause serious health issues. Third, our environment will be preserved for the future generations that need the land and water to be clean to sustain life.

NEXT STEPS FOR RESEARCH AND EXPERIMENTATION

In the future, using the same hypothesis, we could test different plants like spinach and strawberries. We could test with different amounts of the pesticides on the plants. Also, we could alter the formula for the homemade organic pest control by testing just neem or neem and garlic. We would like to retest the effect of different pesticides on worms and crickets to obtain more valid data. Also, our team could change the experiment by testing different locations to see if the same results will occur at the drier parts of the island of Oahu. We had an idea to use time-lapse photography to observe the bugs reaction to neem.

We would like to research more about other crop management techniques like rotating crops at certain seasons and using beneficial pests to rid the harmful pests.

WE HAVE IMPLEMENTED OUR SOLUTION

See attached Photos--Community Benefit for photos 19 to 24. To spread the word “Don’t Panic, Grow Organic”, our team made presentations and distributed sample bottles of our homemade pest control at the Kahumanu Farm Festival, at NOAA Center’s Student Science Conference, Lanikai Elementary School, Kailua Intermediate School, and Punahou School.

See photo 21 of our presentation board, booklet to farmers, and sample bottle of homemade organic pest control. We compiled a booklet to distribute to non-organic farmers that includes information on new legislation that gives farmers up to $50,000 in tax credits for qualifying expenses, which include application fees, inspection costs and equipment or supplies needed to produce organic products. The purpose of this Act was to encourage more farmers to convert to organic farming.

Please see the section below called ANALYSIS: COST OF PESTICIDE AND PRICE OF KALE, ROSEMARY AND CILANTRO. This part was an important section of the booklets because farming is a business, and we need to convince the farmers that converting to organic agriculture can be profitable.

See attached Map which shows an aerial view of the Kahumana organic farm and the surrounding farms that use synthetic pesticide. You are able to see that the other farms are very close to Kahumana. When they spray synthetic pesticide the wind blows the toxic chemicals to Kahumana farm and endangers their organic produce. Also the farm workers can feel the pesticide presence because they get itchy eyes. We will distribute our booklet on results and sample organic spray to 3 of these farms near Kahumana.

When we presented to students, we pointed out that they should ask their parents to buy organic fruits and vegetables from now on. If all of us buy organic, then the farmers will meet the demand by growing and supplying more organic produce to consumers. Maybe the price of organic produce will then become lower for consumers if the farmers are able to buy organic pest control in larger bulk at lower cost expenses to their farming business or maybe the farmers can grow the ingredients and make the organic pest control themselves.

IMPLEMENTING OUR SOLUTION IN THE FUTURE

We asked Representative Chris Lee for suggestions on how we can further implement our solution to help our community. He said he can introduce us to a few good folks at the Hawaii Dept of Agriculture that can guide us. He also said that if we win the $5,000 grant from Ecybermission, the Dept of Agriculture might match that with another $5,000 grant to help us implement our solution!

We would like to continue this project in the future. One idea is to manufacture and sell our homemade organic pest control in spray bottles. See Photo 21 of a spray bottle with our homemade organic pest control with cool marketing using our Lanikai Science Squad logo. If we can make organic pesticide affordable and accessible to farmers, then why wouldn’t they use it instead of poisoning the people and environment of Hawaii?

Our team brainstormed other good ideas for the future:
--compile a fact sheet of how organic pest control is better
--rent a booth at the People’s Open Market in our town on Sundays to distribute the fact sheet and sell the bottles of organic pest control
--make buttons with our slogan “Don’t Panic, Grow Organic”
--make a presentation at the Hawaii Farmers Union about organic pest control
--rent a booth at a science event or expo to spread the word about organic is good
--followup with Dr. Goodale of China that we met at the IUCN World Conservation Congress

Our poster board and an extra booklet are ready in case we are asked to present the results of our experiment to farmers or students. We are ready to spread the word -- DON’T PANIC, GROW ORGANIC!

ANALYSIS: COST OF PESTICIDE AND PRICE OF KALE, ROSEMARY, AND CILANTRO

Our team’s goal is to convince farmers to convert to organic production of crops to benefit people’s health and the environment. How can we motivate them to change?
1. Protect the environment from toxic chemicals so you can keep farming that soil for many years.
2. Live a long and healthy life by breathing air and eating food without toxic chemicals and drinking clean water.
3. Organic certified crops command higher prices which might justify the greater expenses of organic farming, and might net a higher profit for their business.

To make a change, farmers need to evaluate the economic potential of the price of organic produce versus the cost of organic farming. We conducted our own study and collected data on prices and costs as explained below. (See attached Tables 15 thru 18.)

Table 15 shows the cost of both organic and synthetic pesticides per ounce. We gathered the costs at a retail store and the cost that farmers would pay to buy in bulk from a retail store. For our homemade formula, we used the retail price of the ingredients Hawaiian chili peppers, garlic, neem oil, and included the cost of the spray bottle. We understand that there are additional costs involved like the labor and time it takes to chop the vegetables yourself.

Cost Analysis:

We conclude that making organic pesticide yourself is the least expensive way to afford effective pesticide. Our homemade formula is $.13 per ounce. Another possible idea to reduce the cost of organic pest control is to grow the ingredients on your farm. Our research shows that all three ingredients of our formula grow in Hawaii -- Hawaiian chili peppers all over Oahu and other islands, elephant garlic on Maui, and neem trees in Waimanalo.

We interviewed Representative Chris Lee, who introduced the new legislation in Hawaii that aids farmers’ organic certification. Farmers receive a $50,000 tax credit to offset the cost of getting certified as organic by the U.S. Dept. of Agriculture, and qualifying expenses, which include application fees, inspection costs and equipment or supplies

needed to produce organic products.

Tables 16-18 show the retail and wholesale prices of both organic and non-organic kale, rosemary, and cilantro from 5 different retail stores. We also have price information on basil from our 6th grade Mission Folder. From the updated interview with Kellie Gutheil-Lee of Herbco International Farms, we obtained wholesale prices of produce.

Price Analysis:
--Retail price of organic kale is about 2 times more than non-organic kale.
--Wholesale price of organic kale is about 2 times more than non-organic kale.
--Retail price of organic and non-organic rosemary is about the same.
--Wholesale price of non-organic rosemary is about 44% higher than organic rosemary.
--Retail price of organic and non-organic cilantro is about the same.
--Wholesale price of organic cilantro is about 21% greater than the non-organic cilantro.

Therefore, farmers can recoup the extra expenses of organic farming by selling organic produce at a premium. This is value-added agriculture that grocery stores and their customers are willing to pay for. Also, the new $50,000 tax credit is a great incentive to convert to organic farming.

Uploaded Files:

- [View] **Map** (By: memma808, 02/14/2017, .jpg)
  Map of Kahumana Organic Farm and surrounding non-organic farms.
- [View] **Tables 15-18** (By: memma808, 02/14/2017, .pdf)
  Tables 15-18 Cost and Price Analysis
- [View] **Photos-Community Benefit** (By: memma808, 02/16/2017, .pdf)
  Photos 19 to 24 of our team making presentations on our organic pest control research.

Mission Verification

(1) Does your Mission Folder project involve vertebrate testing, defined as animals with backbones and spinal columns (which include humans)? If yes, team must complete and attach an IRB approval form.

No

(2) Did your team use a survey for any part of your project? If yes, team must complete and attach a survey approval form.

No

(3) You will need to include an abstract of 250 words or less. As part of the abstract you will need to describe your project and explain how you used STEM (Science, Technology, Engineering and Mathematics) to improve your community

How do we solve the community problem of synthetic pesticides harming humans and our environment in Hawaii? DON'T PANIC, GROW ORGANIC!

Our experiment can help solve the problem of pesticide poisoning because we found a less expensive replacement for synthetic pesticide. The solution is homemade organic pesticide with neem oil.

We tested the effects of different pesticides on kale, rosemary, and cilantro. One garden box had no pesticide for the control, one box was treated with synthetic pesticide, and one box was treated with organic pest control with neem oil. We applied the pesticides to the plants every week and measured them every two weeks. Our data shows that organic pest control works just as well as synthetic pesticide in preventing pests from damaging plants, grows just as well in size and shape, and is richer in healthy chlorophyll.

In the future, our team could test different plants, amounts of pesticides, altering the organic pest control formula, and testing in different locations. We also want to sell our organic pest control to make it affordable and accessible. Farmers can be proud that their produce is organic and healthy for the community.

We used STEM to improve our community through agriculture, chemistry, measurements, and a microscope. We used computers for research and programs to make charts and measuring RGB. We used math to calculate the differences in measurements and averages of growth, price differences of wholesale and retail for organic and non-organic produce, and compared the cost of pesticides.

Lanikai Science Squad – Team Action Plan

August 2016

- Team formation: Heather, Emma, Lily, Jasmine
- Team name: Lanikai Science Squad
- Registered ECM team and reviewed rules
- Mission Challenge: Environment
- Problem Idea: Synthetic pesticide harmful vs organic pest control safer
- Design logo for team Tshirts, folders

Aug-September 2016

- Created team action plan with schedule and responsibilities
- Research: Excursion to Leilani Farm to interview organic farmer; dangers of chemicals in pesticide
- Began experiment: Planted kale and cilantro
- Research: Excursion to Conservation Convention to talk with scientists from around the world
- Planted rosemary because cilantro died
- Conducted experiment 6 weeks: Made organic pest control solution; sprayed pesticides weekly; gather data every 2 wks

Oct-Nov 2016

- Gathered data: measure kale and rosemary height, width, counted bugs, moisture meter, took photos
- Captured insects, observed under microscope to identify
- Research: Excursion to Aloha Aina Nursery to interview Dr. Saleem Ahmed, expert on neem trees and pest control
- Conduct RGB test on leaves; observe leaves under microscope

Dec 2016-Jan 2017

- Research: Interview Mr. Christian Zuckerman of Kahumana Organic Farm
- Gather data on 2nd experiment: Sprayed pesticides on meal worms and crickets
- Analyze all data and research material; make tables and graphs
- Create poster of our experiment and data for presentations
- Presentation to classmates of results of organic pest control experiment on kale and rosemary

February 2017

- Research: Cost analysis of pesticides with Ms. Kellie Gutheil-Lee of Herbco Intl. and price analysis of organic vs non-organic kale, rosemary, cilantro
- Present farmers a sample of our home made organic pest control and results of experiment
- Team effort to complete online Mission Folder by deadline

LANIKAI SCIENCE SQUAD – TEAM RESPONSIBILITIES

EMMA	HEATHER	LILY	JASMINE
Spokesperson for interviews and presentations	Artistic designed logo for Tshirts	Gardening experience in Green Club	Organizer
Computer Wiz	Photographer	Researcher	Researcher
In charge of worms	Cooking skills for team snacks and recipe for organic pest control solution	Writing skills	Speaks French
Leadership skills	Creative	Creative	Note taker
Competitive spirit encouraged and motivated others	Grew plants at her house. In charge of plant care and maintenance	Encourages others to persevere	In charge of RGB color test on leaves.
Obtained pest control homemade formula	Writing skills	Critical thinker	Time Manager
Writing skills	Capture insects and identify under microscope	Keeps team on task	In charge of poster for presentations
Analyst	Analyst	Analyst	Analyst
Family works in farming industry	Coordinates team meetings at her house	Competitive triathlete spirit encouraged team to strive higher	Innovator with microscope
Bilingual English/Chinese to speak with farm workers	Mathematician	Note taker, data collector, and mathematician	Mathematician
Innovator	Prepare charts, graph, schedule	In charge of crickets	Good listener and cooperative
Problem solver	Encourages team with food	Prepared results in booklet for farmers	Encourages team with calm logic

LANIKAI SCIENCE SQUAD – EXPERIMENT SCHEDULE

TASK	TEAM MEMBER	DUE DATE
Register ECM team and review rules	Emma, Heather, Lily, Jasmine	8/31/16
Select team name	Emma, Heather, Lily, Jasmine	8/31/16
Design logo for Tshirts	Heather in charge, Jasmine	8/31/16
Create new Google Drive ECyberMission 7th Grade Folder shared with team	Heather	8/31/16
Science project topic ideas	Emma, Heather, Lily, Jasmine	8/31/16
Create team action plan	Emma, Heather, Lily, Jasmine	8/31/16
Excursion to Leilani Organic Farm to interview farmer	Emma, Heather, Lily, Jasmine	8/6/16
Research how to grow kale and cilantro, different organic pesticides	Emma, Heather, Lily, Jasmine	8/31/16
Make batch of organic pest control with neem oil	Emma, Heather, Lily, Jasmine	8/31/16
Begin experiment: plant kale and cilantro seedlings	Emma, Heather, Lily, Jasmine	8/31/16
Excursion to Conservation Convention to discuss pesticide with scientists from around the world	Emma, Heather, Lily, Jasmine	9/3/16
Experiment: plant rosemary because cilantro died	Heather, Lily, Jasmine	8/27/16
Research synthetic pesticides harm to humans and animals	Lily in charge	9/30/16
Conduct experiment for 6 week: Apply pesticide every week; gather data every 2 weeks on growth measurements, count bugs, moisture meter reading, photos	Emma, Heather, Lily, Jasmine	10/31/16
Capture insects and observe under microscope and take photos	Heather, Jasmine, Lily	11/8/16
Excursion to Aloha Aina Nursery to interview Dr. Ahmed, expert on neem	Emma, Heather, Lily, Jasmine	10/15/16
Conduct tests on plant leaves: RGB color tests, observe chlorophyll of crushed leaves under microscope	Jasmine in charge, Heather, Lily	11/8/16
Interview organic farmer, Mr. Zuckerman	Emma	1/15/17

Second experiment: Apply pesticides to meal worms and crickets and observe reaction and behavior for one week	Emma in charge of worms, Lily in charge of crickets	1/15/17
Analyze data and research material to create tables and graphs	Emma in charge, Heather, Lily, Jasmine	12/31/16
Create poster of data and photos for presentations	Jasmine in charge, Heather, Emma, Lily	1/15/17
Presentations to students of results of organic pest control experiment on kale and rosemary	Emma or Heather in charge, Lily, Jasmine	1/31/17
Research neem oil	Heather	12/31/16
Gather cost of pesticides from stores	Heather	2/4/17
Gather price of organic vs non-organic kale, rosemary, and cilantro from 5 grocery stores	Emma, Heather, Lily, Jasmine	2/4/17
Present to farmers a sample of our home made organic pest control solution with neem oil and results of our experiment	Lily in charge of preparing booklets, Emma in charge of distributing booklets	2/11/17
On ECM rubric, volunteer to be responsible in answering specific questions on Mission Folder	Emma, Heather, Lily, Jasmine	2/22/17
Upload photos with captions	Heather	2/22/17
List resources in Bibliography	Lily	2/22/17
Input answers to questions in the ECM Mission Folder and upload attachments	Emma, Heather, Lily, Jasmine	2/22/17

Mission Folder: View Mission for 'Basil Cello Scientists'

State	Hawaii
Grade	6th
Mission Challenge	Environment
Method	Scientific Inquiry using Scientific Practices
Students	Memma808 basilcello2 mrplurp

Team Collaboration

(1) Describe the plan your team used to complete your Mission Folder. Be sure to explain the role of each team member and how you shared and assigned responsibilities. Describe your team's process to ensure that assignments were completed on time and deadlines were met.

Our 6th grade ECyberMission team members are Emma, Heather, and Ella. We have been friends at the same elementary school since kindergarten. We formed an ECyberMission team because we are cello players in the after school orchestra program, and we wait one hour and 20 minutes after school for our advanced class to begin on Wednesdays and Fridays. So we decided to be productive with a fun science project that can help the people of Hawaii. We named our team Basil Cello Scientists.

All three of us are good honor roll students and strive for excellence in academics. We knew each of us would contribute to this project and be responsible for our part of the experiment. No one member was the sole leader, and no one delegated the assignments. In this group, we each VOLUNTEERED to complete different parts of the research and experiment that interested us and we were skilled at. Once we decided on the community problem and how we wanted to help solve it, the steps to complete the challenge were logical for the three of us to plan. See the attachments called Team Action Plan and Team Responsibilities. They show the role of each team member and how we shared responsibilities that we volunteered for. Many of the tasks were shared by all three of us because we live near each other, and it was easy and fun to get together to work on this project.

See the attachment called Timeline. We started in October 2015, giving us five months to complete the mission challenge. We met weekly to brainstorm, ask questions, and talk about our ideas. To remind each other about assignments due by the next meeting dates, we communicated through emails, text, and talking with each other since our homerooms are close. We had a paper calendar to mark the dates of our meetings and project tasks. The due dates for the tasks were the next meeting dates that we agreed on based on our schedules and other school homework assignments.

We followed the ECyberMission website to guide us on the rules, deadline dates, what forms were needed, and how the judging is conducted. We each had a Basil Cello Scientist project folder for our individual research. Then we put everything together in a 3-ring binder as our foundation to input information to our online Mission Folder.

From the beginning of this project, we decided to use Google's gmail Drive to share documents and notes. We learned how to use Google Drive in school and feel good about actually applying what we learned in an important group project. This skill will help us in the future as we attend high school, college, and in the job world. After the experiment part was finished, we each volunteered to answer different questions on the Mission Folder by first drafting our answers in a Google doc. The draft was then reviewed and revised by the other two team members. After all three of us agreed it was a good and complete answer, then it was input to our Mission Folder.

One week gave us time to complete our chosen assignments by the due dates. Only a few times, the assignments were not completed, and the other team members helped out to meet the ultimate deadline of February 29, 2016 to submit the entire completed Mission Folder.

All three of us encouraged each other to keep working hard on this project. Sometimes we were in the meetings and felt tired and confused, so Ella would suggest we go outside the classroom and run around in the grassy hill nearby for a few minutes. This felt good to get some fresh air to clear our minds and release a burst of energy, and we were able to continue brainstorming good ideas. We had some meetings at Heather's house, and when we were getting tired, she cooked us delicious grilled cheese sandwiches to encourage us to keep writing. Emma has strong computer skills, and she encouraged us to make graphs and charts by teaching us how to set them up and how to convert them to pdf files to upload. When all but 2 of the basil seeds died after one month, we were disappointed and worried about how to complete our experiment. We encouraged each other to not quit, and we found Leilani Nursery wholesales organic basil seedlings at a store nearby, and we were able to continue with our experiment.

We always had the goal of completing the best science project we can be proud of. (See Photo 15) After our experiment was completed, we harvested the basil leaves from the organic pesticide and control pesticide. We used the basil to cook pesto pasta sauce on ravioli. It was delicious! We felt good knowing the basil was clean and healthy without chemicals.

Emma has been our student body leader, JPO captain, and Green Team leader. She competes on the swim team and volleyball team. Emma is a good leader and public speaker, which was very helpful when we were conducting the taste test with our classmates. Emma explained the test clearly and made sure the students were taking the survey seriously. Also, she was not afraid to touch the worms in the other part of the experiment. Emma is skilled with computer programs and created the tables.

Ella practices karate. She is good at research and writing. Ella is good at remaining calm, so she was good at encouraging us to keep working on this project even when we were tired and had other school projects due. Ella is on the Green Team garden club and had knowledge about the worms, and she helped us nurture the basil plants.

Heather takes tennis and cooking classes. She is very artistic and drew the logo for our Basil Cello Scientist pink T-shirts and project folders. She drew the insects we observed under the microscope, created the pie chart, and selected the best photos. Heather lives between Ella and Emma, and had an area in her front yard for our basil plants to grow. We met at her house to plant the basil, make the organic pesticide, spray the two pesticides on the basil, conduct the worms test, and harvest the basil to

cook pesto sauce on ravioli.

Unofficial members of our Basil Cello Scientists team are our family members. We want to thank our parents and our team advisor for helping and guiding us to complete this science project.

Uploaded Files:

- [**View**] **Timeline** (By: basilcello2, 02/07/2016, .pdf)

  Timeline for Basil Cello Scientists to complete ECM challenge.
- [**View**] **Team Action Plan** (By: basilcello2, 02/07/2016, .pdf)

  Chart of Basil Cello Scientists tasks to complete ECM Mission Folder, team member responsible, and due date of assignment.
- [**View**] **Team Responsibilities** (By: mrplurp, 02/12/2016, .pdf)

  Chart of the main responsibilities that each team member contributed to complete the Mission Folder.

Scientific Inquiry

Problem Statement

(1) What problem in your community did your team try to solve? Why is this problem important to your community?

HOW DO WE STOP SYNTHETIC PESTICIDES FROM HARMING HUMANS?

In Hawaii, farmland accounts for 27% of Hawaii's total land useage. There are 7,500 farms in Hawaii, but only 152 of those farms are certified organic farm operations. That means 98% of the farms in Hawaii are using synthetic pesticide on their crops (A Look at Hawaii Agriculture, 2010). This is an important problem in Hawaii because research has shown that the chemicals in synthetic pesticide are harmful to humans. It can lead to serious health issues such as cancer, reproductive dysfunction, diabetes, autism, birth defects, and Alzheimer's disease (Wide Range of Diseases Linked to Pesticides, 2010).

To learn more about this community problem, we took an excursion to Kahumana Farm in Waianae, Hawaii (see attachment Photo 1, permission given to use this photo by CEO, Tom McDonald), to interview the farmer of this non-profit organic farm named Mr. Christian Zuckerman (see attached Interview 1). Mr. Zuckerman told us about the community problem of how chemicals in pesticide runoff can cause harm to neighboring organic farms. Also, when it is windy, the synthetic pesticide blows over to his farm and irritates people by causing itchy eyes. Mr. Zuckerman said there are environmental impacts from the chemicals in pesticides and fertilizers that sink into the soil and get into our water source and then gets into us when we drink the water (Zuckerman, 2015).

A 12/4/2015 article in the Honolulu Star Advertiser newspaper explains how pesticide exposure can cause as much damage to the children's lungs as secondhand cigarette smoke (see attachment Newspaper 1). This experiment was on children of farmworkers in California, but the same lung damage may be happening to children of farmworkers in Hawaii (Mohan, 2015).

(2) List at least 10 resources you used to complete your research (e.g., websites, professional journals, periodicals, subject matter experts).

See attached Resources for a list of resources used by Basil Cello Scientists research and grouped by category.

See the attached Bibliography for a complete list of all resources used by Basil Cello Scientists to complete this Mission Folder.

(3) Describe what you learned in your research.

HAWAII'S ORGANIC AND NON-ORGANIC FARMS, AND PESTICIDES
In Hawaii, farmland accounts for 27% of Hawaii's total land useage. There are 7,500 farms in Hawaii, but only 152 of those farms are certified organic farm operations. That means 98% of the farms in Hawaii are using synthetic pesticide on their crops (A Look at Hawaii Agriculture, 2010).

Kathy King, statistician for the Hawaii office of USDA, said organic food production in Hawaii appears to be growing despite challenges such as plant pests. As of 10/26/2016, there were 166 organic farms in Hawaii generating $13.4 million last year. The average size of an organic farm is 21 acres. The report said 37% of the organic farmers sold to retailers, 35% to wholesalers, and 28% to consumers. Una Greenaway, president of Hawaii Organic Farming Association, said most of the farmers became organic farmers because they were concerned about pesticides (Gomes, 2015). We wrote to Ms. Greenaway for more information about organic farming, but she has not replied yet.

Mr. Christian Zuckerman is an organic farmer at Kahumana Farm in Waianae, Hawaii (see Photo 1). He told us about the community problem of how chemicals in pesticide runoff can cause harm to neighboring organic farms. Also, when it is windy, the synthetic pesticide blows over to his farm and irritates people by causing itchy eyes. Mr. Zuckerman said there are environmental impacts from the chemicals in pesticides and fertilizers that sink into the soil and get into our water source and then gets into us when we drink the water. The synthetic pesticide blowing to his farm can jeopardize his organic certification status. (Zuckerman, 2015).

Pesticides are chemicals that kill pests or disrupt pest population. A pest is an organism that causes some type of damage to something we value. Pesticides can be grouped into synthetic, organic, inorganic, and biorational pesticides. Synthetic pesticides are manufactured in a laboratory and sold by a chemical company. Organic pesticides are products of living organisms. Inorganic pesticides are minerals that are mined from the earth and ground into a fine powder. Biorational pesticides are like soap and oils, which are low toxicity and exhibit a low impact on the environment (Pesticides, 2004-2016).

SYNTHETIC PESTICIDE IS HARMFUL TO HUMANS AND THE ENVIRONMENT
The chemicals in synthetic pesticide are harmful to humans. It can lead to serious health issues such as cancer, reproductive dysfunction, diabetes, autism, birth defects, and Alzheimer's disease (Wide Range of Diseases Linked to Pesticides, 2010).

Agrochemical supporters assume that small exposures to chemical residue are not harmful. However, independent scientists are debunking that belief and proving that even tiny doses could lead to health problems later in life. Eating organic, less processed foods can decrease your pesticide exposure. Health problems associated with pesticide based agrochemicals: food allergies, memory loss, diabetes, cancer, autism, obesity, Parkinson's disease, infertility, birth defects, Alzheimer's disease (10 Crazy Things Pesticides Are Doing to Your Body, 2012).

An experiment at the 2005 California State Science Fair on how long pesticide will remain toxic in different soils and in different environments. Their results on different soils are as follows: clay loam-- pesticide did not last very long average of only 3.6 days; sand-- pesticide remained toxic for 7.6 days; regular soil -- pesticide remained longest in this soil for 12.6 days (Russell, 2005).

A 12/4/2015 article in the Honolulu Star Advertiser newspaper explains how pesticide exposure can cause as much damage to the children's lungs as secondhand cigarette

smoke. In Salinas Valley, California, 279 children from farmworker families were followed since birth for 15 years. At age 7, they were given exhalation measuring tests. Researchers found a decrease in lung function by 8% less air exhalation (Mohan, 2015).

An article in National Geographic talked about water areas with a lot of pesticide observed the population of birds annually decrease by 3.5% (Second Silent Spring? Bird Declines Linked to Popular Pesticides, 2014).

Between November 2006 an April 2008, Waimea Canyon Middle School on Kauai experienced several incidents of chemical odors affecting students and teachers. The unidentified odors caused the students to be evacuated from school and seek medical treatment for dizziness, headaches, and nausea. These symptoms are consistent with exposure to volatile chemicals (Are There Safe Levels of Pesticide Exposure, 2015).

Pesticides sprayed on land make their way to water sources such as rivers, oceans, or ponds due to runoff. Many fish and other animals die and this can throw the whole ecosystem off balance. Pesticides also affect groundwater by leeching. Many people depend on groundwater for their water supply and pesticides make it unsanitary and harmful to drink. Another way pesticides spread potential harm is volatilization, which occurs when pesticide turns to gas or vapor and travels through the air and spread to different land areas (Jakuboski, 2011).

Seven children were hospitalized and a total of 11 people sickened in Kahuku, Hawaii in 2007, when fumes from an organophosphate insecticide drifted over the school from a nearby sod farm. Pesticide drift is undermining the health and livelihood of families across the country. PAN (Pesticide Action Network) works with partners to support stronger measures across the country to create safer spaces for children to grow (Schools & Playgrounds). We called the Pesticide Action Network at 510-788-9020, and they referred us to the Hawaii contact, Paul Towers. We wrote to Paul Tower of Pesticide Action Network, but he has not replied yet.

ORGANIC PESTICIDE IS SAFER FOR HUMANS AND ENVIRONMENT

Commonly acceptable organic pesticides and fungicides are garlic, chili pepper, neem oil, pyrethrum, diatomaceous earth, copper fungicide, soap, stinging nettle, and sulfur (Fedor, 2001, p171).

Organic pesticides work just as good as synthetic pesticides, but the farmers need to be more persistent. The chemicals are more effective for short term because they keep the bugs away, but in the long term, organic pesticides are better for the plant and people eating them. Kahumana Farm makes their own organic pesticide from neem oil, Hawaiian chili peppers, and garlic (Zuckerman, 2015).

Organic foods have pesticides that come from natural sources such as certain types of plants, and they do not use synthetic pesticides. Organic farmers tend to spray less pesticides on their produce, and the pesticides are less dangerous for the environment. If a product is certified organic, it has to abide by the national standards (Jakuboski, 2011).

The cost of organic pesticide for farmers ranges from $1.25 to $25 an ounce. Farmers use 16 to 64 ounces of organic pesticide per acre. Not all organic pesticides/fungicides are available in Hawaii, so the farmers have to wait 6 to 12 weeks to receive chemicals needed. Organic chemicals in Hawaii are not available in bulk, so the farmers must buy in smaller sizes of quarts, gallons, and 2.5 gallon size, which make the accumulated cost higher than a conventional farmer that can buy huge 300 gallon tanks of conventional chemicals at a time (Gutheil-Lee, 2016).

NEEM OIL IN ORGANIC PESTICIDE IS EFFECTIVE AND SAFE TO HUMANS AND ENVIRONMENT

The organic pesticides containing neem oil are good to use because they kill bugs on contact. As opposed to synthetic pesticides need to be ingested by the pests, which means the bugs need to eat the leaves of your plant in order to eat the poison and then die (Lee, 2015).

If you are interested in using a more environmentally friendly product, you may investigate Azadiractin, which is an extraction naturally produced by the Neem tree, and is also known to gardeners as neem oil. These products provide the gardener with another option for controlling basil plant marauders (Gulf Coast Herb Society Newsletter, 2013).

Approved organic controls for fruit flies is neem. In research tests, neem-treated sand was found to be toxic to oriental fruit flies and medflies but not to several beneficials. This suggests potential for soil treatment to inhibit fruit fly development in fields (however, adults may still invade from outside areas). Azatin® is a neem product registered for use in Hawaii as a soil treatment against fruit fly larvae. The National Organic Standards Board has approved use of neem in certified fields, but it is still investigating the inert ingredients in Azatin (Messing, 1999).

Neem is a key ingredient providing a natural alternative to synthetic pesticides. Neem seeds from the neem tree are ground into a powder that is soaked overnight in water and sprayed onto the crops. It needs to be reapplied at least every ten days. Neem does not directly kill insects on the crop, it acts as an anti-feedant, repellent, and egg-laying deterrent. This protects the crops from damage because the insects starve and die within a few days (Azadirachta indica).

Neem enters the system and blocks the real hormones from working properly. Insects forget to eat, mate, and they stop laying eggs. The insects are too confused to eat or breed and will not survive. Neem works at very low concentrations, so a little neem goes a long way. The mere hint of a smell of neem oil seems to be enough to keep leaf eating insects away. This hormonal effect is the key to neem oil being an effective insecticide and good for the environment (Is It Safe to Spray Neem?).

You should only spray neem at times when beneficial insects like bees and ladybugs are not active like early morning or late afternoon. Once the spray has dried it is not harmful to good insects any more, only to sucking and chewing bugs. It is safe to spray neem on yourself as long as it is pure neem oil in the pesticide, and neem is actually good for your skin. Neem oil can safely be sprayed on edible fruits and vegetables right up to the day of harvest (Is It Safe to Spray Neem?).

Many pesticides break down quickly and wash away with rain. Farmers have to spray frequently or use strong chemicals that are stable to stay around. That means chemical buildup in our soil and water supplies will eventually poison everyone. However, neem oil breaks down quickly in UV light but is a systemic insecticide. This means when it gets into the soil, the plant absorbs it and takes it up to their tissue, and the neem works from the inside (Is It Safe to Spray Neem?).

People eat neem leaves to cleanse the blood, stimulate the liver, and boost the immune system. Humans do not need to worry about a small amount of neem inside their vegetables. (Is It Safe to Spray Neem?)

HOW TO GROW BASIL IN HAWAII

Basil is one of the most popular herbs in the garden. Basil adds fine flavor to tomato dishes, salads, and pesto. Plant the basil seeds in full sun, in well-drained soil enriched with compost, aged manure, or other organic materials. Pinch plants frequently to encourage bushy growth, and pinch off flower heads regularly so plants put their energy into foliage production (Basil A Growing Guide, 2011).

Basil plants grow well in Hawaii if they receive a lot of sun. Some basil plants have a fungicide, mildew problem lately because of the heavy rain this fall. The pest that eats basil leaves is usually slugs and snails. The seeds will take about 6 weeks to grow to a bush. It is hard to wash pesticide off the leaves of basil plants (Kim, 2015).

In April 2012 the Hawaii Dept of Health discovered some basil produced on Oahu was contaminated by illegal pesticide residues. Tests show at least four different farms showed the illegal residues are above the established tolerance level for the crop. Basil is one of Hawaii's larger export crops to North America. In Hawaii, growing basil supports many dozens of farms and their families (Some Oahu Basil Farms Apply Pesticide Improperly, 2012)

In October 2015, Hawaii Health Dept found high unacceptable levels of pesticide on Thai basil from a Waianae farm. Delivery was halted and 5,000 pounds of Thai basil at Wong Hon Hin's farm were ordered to be destroyed. The Hawaii Department of Health said in its news release that it "conducts routine screening of raw agricultural commodities from major distributors, farmers markets, and large farms throughout the state to ensure locally grown fruits and vegetables meet state health standards for food safety" (High Levels of Pesticide Found on Thai Basil from Waianae Farm, 2015).

PESTS THAT DAMAGE BASIL
Fruit flies have become serious pests in Hawaii since the first species was found here in about 1895. They are widespread, occurring from sea level to above 7000 ft elevation, and feed on hundreds of host plant species, many of which are economic crops (Messing, 1999).

Fruit Flies are light brown, usually with red eyes. They will fly slowly and openly around the garden and congregate on fruit or other vegetative matter. (Identifying Flying Insects).

Fruit flies are nuisance pests that are attracted to fermenting and ripened fruit and vegetable matter. They can multiply quickly -- one female can lay up to 700 eggs in the four weeks that make up her lifetime. In hot summer weather, these eggs can turn into adult fruit flies within one week. Additionally, fruit flies can spread bacteria that contain disease-causing agents (Caines).

Slugs eat large ragged holes in the leaves of basil and many other plants. They feed at night and hide under mulch, plant leaves and rocks during the day. Japanese beetles are the culprit when the leaf tissue is devoured and just the veins remain. Pluck these insects off the plants and drop them in soapy water or try neem. Neem is an eco-friendly product that can help control small populations of Japanese beetles (Myers).

Hypothesis

(4) State your hypothesis. Describe how your hypothesis could help solve your problem.

If farmers stop using synthetic pesticide and switch to homemade organic pesticide at a reasonable cost, then the produce will not be destroyed by pests, they will grow just as well in size or shape, they will taste better without chemicals on them, and humans will no longer be harmed by the toxic chemicals in the vast amount of synthetic pesticide being used in Hawaii's environment.

For the primary experiment, the independent variable will be the different pesticides sprayed on the basil plants -- organic and synthetic. The dependent variable will be the basil plants -- how much they grow, how many bugs on them, and how good the basil leaves taste. The control group will be the 3 basil plants that are left in their natural state, which is with no pesticide.

For the secondary experiment, the independent variable will be the different pesticides sprayed on the worms -- organic and synthetic. The dependent variable will be the effect on the worms. We will observe how the worms react to the pesticides and how many days they survive.

We are testing the different pesticides on basil because basil is one of the hardest plants to wash pesticides off of the leaves. We are trying to find a low cost replacement for synthetic pesticide. We believe a homemade pesticide of organic materials is the solution, and it will not harm humans or our environment.

(5) Identify the independent variables and the dependent variables in your hypothesis.

The independent variable of this project are the different kinds of pesticides that were sprayed on the three sets of basil plants. On one set, we sprayed synthetic pesticide, on another, we sprayed an organic pesticide that we had made ourselves, and on the last set, we sprayed no pesticide for a control group. The dependant variable for this project is how the basil plants grow and taste, and how many insects are on the basil plants.

(6) How did you measure the validity of your hypothesis? (In other words, how did you determine that your hypothesis measures what it is SUPPOSED to measure?)

To test our hypothesis, our group met up every week to spray pesticides on the basil plants. Every 2 to 3 weeks, we used a yardstick to measure each set of basil plants to observe their growth. We used a chart to record how many inches in height and width they were with yardsticks. During this time we also observed and took photos how many bugs were on the basil leaves. This procedure helped us measure the validity of our hypothesis that organic pesticide plants will not have insects destroying them, and the plants will grow just as well as the plants with synthetic pesticide on them.

To measure the validity of our hypothesis that organic basil will taste better than basil with chemicals sprayed on the leaves, we conducted a survey on students at school on the best tasting basil. We also did the same survey with our friends and families at home. We took notes on what the test subjects said about how each basil plant tasted. We had a total of 50 participants in this survey and believe that is enough for an accurate result.

Finally, we conducted an experiment to observe the effect of different pesticides on worms. To test this, we had three containers to put an equal amount of 50 worms and 6 basil leaves inside each container. Then we sprayed the synthetic pesticide in one container and organic pesticide in another container, and did not spray pesticide in the third container. We observed and timed how long it took for the different pesticides to eradicate the worms. This procedure helped us measure the validity of our hypothesis that organic pesticide will prevent insects from destroying the plants.

Experimental Design

(7) List the materials you used in your experiment. Include technologies you used (e.g., scientific equipment, internet resources, computer programs, multimedia, etc.).

MATERIALS TO GROW BASIL PLANTS
organic soil
organic fertilizer
basil seeds
8 small seedling pots
water
9 organic Thai basil seedling plants

3 garden boxes 28"long x 12"wide x 10"deep
garden hand spade tool
9 plastic plant markers/signs
black sharpie pen
3 yardsticks
chart paper to record measurements
pen
camera

MATERIALS TO MAKE ORGANIC PESTICIDE
blender
Hawaiian chili peppers
neem oil
garlic
warm water
knife
cutting board
measuring spoon
measuring cup
spoon
strainer/collander
empty spray bottle
black sharpie pen
plastic gloves
large black trash bags
spray bottle of synthetic chemical pesticide
chart paper to record observations
pen
camera

MATERIALS TO TEST THE EFFECT OF PESTICIDE ON WORMS
batch of our homemade organic pesticide in spray bottle
spray bottle of synthetic chemical pesticide
120 meals worms in bran
our basil leaves without pesticide
3 plastic containers with clear lids
watch timer
sewing pin to punch tin holes in plastic cover so worms can breathe
black sharpie pen
chart paper to record observations
pen
camera

MATERIALS FOR BEST TASTING BASIL SURVEY
our basil leaves from 3 groups of organic pesticide, synthetic pesticide, and no pesticide
water
collender
paper towels
zip lock bags
black sharpie pen
4 small bowls
bag of M&M candies
chart paper to record survey votes and observations
pen
camera

MATERIALS TO CAPTURE AND IDENTIFY PESTS ON BASIL LEAVES
small zip lock bags
microscope
chart paper to record our observations
pen
camera

TECHNOLOGY USED
computer internet Google Earth, Bibme.org
computer scanner, printer, copier
computer Google Drive, Google Docs, Google Sheets
Microsoft Word Drawing Tools for charts
Apple Numbers for pie chart

MATERIALS FOR PRESENTATIONS
poster board
print out of charts, photos, results, recipe
scissors
glue stick
folder booklets
green sharpie pen
black sharpie pen

3 small empty spray bottles
another batch of our homemade organic pesticide
small printout of our Basil Cello Scientists logo

(8) Identify the control group and the constants in your experiment.

PRIMARY EXPERIMENT: SPRAYING ORGANIC AND SYNTHETIC PESTICIDES ON BASIL PLANTS
Control group: Three Thai basil plants in the same garden box that are left in their natural state, which is with no pesticide sprayed on them.

Constants:
the 9 basil plants are all the same type called Thai basil
the 9 basil seedling plants are starting the experiment at about the same size in height and width
the 9 basil plants are starting the experiment with healthy green leaves without holes or tears
size of the 3 garden boxes
amount of organic soil
amount of organic fertilizer
amount of water given at the same time
amount of rain water
amount of exposure to sunlight
temperature, wind and humidity
exposure to pests day and night
9 Thai basil plants are located next to each other
time duration of 2 months to grow and react to pesticide
yardsticks to measure plants accurately

SECONDARY EXPERIMENT: SPRAYING ORGANIC AND SYNTHETIC PESTICIDE ON WORMS
Control group: 50 worms in a plastic container with 6 basil leaves and bran, and 9 pinsize airholes are left in their natural state, which is with no pesticide sprayed on them.

Constants:
meal worms from the same pet store
plastic containers
bran
6 basil leaves with no pesticide sprayed on them
temperature, wind, and humidity
after spraying pesticide separately, the 3 containers were placed next to each other
time duration of 6 days to react to pesticide

(9) What was your experimental process? Include each of the steps in your experiment.

PRIMARY EXPERIMENT: SPRAYING ORGANIC AND SYNTHETIC PESTICIDE ON BASIL PLANTS

PLANTING BASIL SEEDS
(See Photo 2 Planting basil seeds in organic soil with organic fertilizer.)
1. Collect 9 small planters.
2. Put organic soil into the 9 small planters.
3. Use a garden hand spade tool to dig 3 small holes in soil.
4. Put 3 to 4 basil seeds in each hole.
5. Put a little bit of organic fertilizer in and around each hole.
6. Cover the holes back up with soil and pat the soil down gently.
7. Place the 9 planters out in the full sun.
8. Water the basil seeds every 3 days.
9. Watch for seeds to germinate and sprout.
(Only 2 basil plants sprouted and died quickly. We found organic Thai basil seedlings at nearby store.)

RE-PLANTING BASIL SEEDLINGS
(See Photo 3 Planting 9 organic Thai basil seedlings in organic soil with organic fertilizer in 3 separate containers to be the control, synthetic pesticide, and organic pesticide.)
1. Place 3 garden boxes about 6 inches apartment in a sunny location. The box on the right is the experiment group using organic pesticide. The box in the middle is the experiment group using synthetic pesticide. The box on the left is the control group with no pesticide. We will do 3 trials of the experiment by placing 3 separate basil plants in each garden box.
2. Put organic soil to fill each garden box about ? full.
3. Use a garden hand spade tool to dig 3 holes in the soil of the left hand side of each of the 3 garden boxes.
4. Re-plant 9 organic Thai basil seedling in each of the 3 holes in the 3 separate garden boxes.
5. Put organic fertilizer about 4 inches wide over the soil on the right side of each of the 3 garden boxes.
6. Cover the holes with soil and pat the soil down gently around the basil seedling plant.
7. Water the basil plants till the soil is moist and water every 3 days.
8. We named each plant so they can be easily identified. We wrote the name of each plant and which group they are in (organic, synthetic, control) on a plant sign and placed it in the soil next to the designated plant.
9. On graph paper, we created a chart listing the plant names, group, dates of observations, height and width measurements, pest count, and observation notes. This became our data tables.
10. Right after we re-planted the Thai basil seedlings, we noted on our data chart the initial measurements of the plants' height, width, number of pests, and observations.
(See Photo 4 Measuring the basil seedlings before applying the pesticide.)

SAFETY PRECAUTIONS
There was an adult supervising us in the kitchen while preparing the organic pesticide recipe. There was an adult supervising us when applying the pesticides. When applying pesticide we wore plastic gloves. The person spraying the synthetic pesticide wore a face mask. We held up plastic bags as a blocking divider between the garden boxes so the pesticide did not blow on the other plants.

MAKING ORGANIC PESTICIDE
(See Photo 5 Making the organic pesticide from garlic, Hawaiian chili peppers, neem oil, and water in a blender.)
1. In a blender, add 2 cups of warm water.
2. Add ½ teaspoon of neem oil.
3. Chop 2 tablespoons of garlic and add to blender.
3. Chop 2 tablespoons of Hawaiian chili peppers and add to blender. 4
4. Blend until smooth liquid.
5. Use a strainer to pour liquid from the blender into a spray bottle.
6. Trash the clumps and seeds remaining.

SPRAYING ORGANIC AND SYNTHETIC PESTICIDE ON BASIL PLANTS
(See Photo 6 Once a week, we sprayed synthetic pesticide on the middle container of 3 basil plants and organic pesticide on the right container of 3 basil plants. We did not spray anything on the left container of 3 basil plants. We used protective gloves and held up plastic bag as a blocking divider between the containers so the pesticide did not blow on the other plants.)
1. At the local hardware store, we purchased a spray bottle of synthetic pesticide called “Sevin”. Once a week, we sprayed this synthetic pesticide on the middle garden box of basil plants. We sprayed from the top of the leaves and underneath the leaves.
2. Once a week for 8 consecutive weeks, we sprayed our homemade organic pesticide on the right garden box of basil plants. We sprayed from the top of the leaves and underneath the leaves.
3. We did not spray pesticide on the left garden box of basil plants.

GATHERING DATA ON THE BASIL PLANTS’ HEIGHT, WIDTH, PESTS
(See Photo 14 We measured the growth of each basil plant’s height and width every 2 to 3 weeks. The last measurement was after applying pesticide for two months.)
1. Using a yardstick ruler every 2 to 3 weeks, we collected data on the basil plants’ height and width measurements. We measured from the tip of the leaves of the highest point of the basil plants to the soil for the height.
2. We measured the tip of the leaves from side to side at the widest point of each plant for the width. We were consistent with accurate measurements taken very carefully.
3. We carefully observed and counted the number of pests on each plant. We also looked under the leaves and on the stems.
4. We immediately recorded the data on the charts we made. We also took photos to document the condition of each plant. Over 2 months of growing the basil plants, we have 4 sets of measurements and counts that were taken every 2 to 3 weeks.
(See Photo 10 Using a microscope to observe, sketch, and identify insects from control basil plant named Penny Lu on 12/31/2015.)
5. Using a small zip lock bag, we scooped in close to capture tiny flying insects on the control basil plant named Penny Lu.
6. We captured two insects and put them on a slide to observe them under a microscope and sketched them to try to identify what type of insects they are. According to our identification process, the flying insects are fruit flies.

SECONDARY EXPERIMENT: THE EFFECT OF PESTICIDES ON WORMS
(see Photo 12 Testing the effect of organic and synthetic pesticides on meal worms.)
1. Remove the clear plastic lids of three plastic containers and use a sewing pin to poke 9 pin size air holes in the covers.
2. Label each cover with a black sharpie pen the type of pesticide that will be used -- organic, synthetic, or none.
3. Put 6 basil leaves with no pesticide on them in each container.
4. Place 50 meal worms in each container with a small amount of bran to eat.
5. Move the container labeled synthetic away from the others and spray 5 squirts of the synthetic pesticide “Sevin” on the worms. Replace the cover.
6. Move the container labeled organic away from the others and spray 5 squirts of our homemade organic pesticide on the worms. Replace the cover.
7. In the container labeled none, do not spray anything on the worms. Replace the cover.
8. For the first 10 minutes, observe the effect of pesticides on the worms and take notes on our chart sheet.
9. Over the next 6 days, observe the effect of pesticides on the worms and take notes on our chart sheet.

BEST TASTING BASIL SURVEY
(See Photo 13 Best tasting basil survey on students at our school.)
1. Get 3 medium size zip lock bags and label them #1, #2, and #3.
2. Pick 15 basil leaves from each of the 3 garden boxes -- organic, synthetic, and control.
3. Wash each set of leaves under running cold tap water. Gently rub across each leaf to remove soil, bugs, pesticide. Shake off the water and lay the leaves on a paper towel. Gently press to remove any water. Let the basil air dry for about an hour.
4. Put leaves from the control basil plants in the bag labeled #1. Put the leaves from the synthetic pesticide basil plants in the bag labeled #2. Put the leaves from the organic pesticide basil plants in the bag labeled #3.
5. Put 3 small bowls on a table top. Put a paper towel down by each bowl and label them #1, #2, and #3. Put a few basil leaves from each zip lock bag down on the paper towel with the matching #1, #2, or #3. (#1 is for the basil leaves from the control group, #2 is for the basil leaves from the synthetic pesticide group, #3 is for the basil leaves from the organic pesticide group. Do not label with the words organic or synthetic or control.)
6. Put a piece of paper next to the bowls and label it #4. This is for people that think all three basil leaves taste the same.
7. Ask the participants to taste a piece of basil leaf from each of the three paper towels and decide which is the best tasting basil.
8. Cast their vote for the best tasting basil by placing an M&M candy into the bowl #1 or #2 or #3. If they think all three basil leaves taste the same, then put the M&M candy by #4.
9. After each vote is cast, cover the top of the bowls so the next participant does not see how many votes each basil received.
10. Each voter receives an M&M candy for participating.
11. Conduct this survey on at least 50 participants to gather a sufficient amount of data about the taste of the basil.

Data Collection and Analysis

(10) Describe the data you collected and observed in your testing (use of data tables, charts, and/or graph is encouraged).

DATA COLLECTION ON BASIL PLANTS GROWTH AND PESTS
Data was collected from 3 trials of each of the 3 groups of basil plants. Two groups were experimental (organic and synthetic pesticide) and one was the control group. First we planted 3 organic Thai basil seedlings in each of the 3 garden boxes. Every week we sprayed organic pesticide on three of the basil plants, synthetic pesticide on three of the basil plants, and we left the other three basil plants with no pesticide to be the control group. We measured each basil plant every two to three weeks to see if the pesticides affected the growth. At the same time, we also counted the number of pests we observed on each of the basil plants.

See Table 1 for the measurements of the basil plants’ height in inches. The average growth in height for the control group is the greatest at 14.1 inches. However, the

average growth in height of 13.6 inches for the organic group is greater than the average growth in height of 13.1 inches for the pesticide group.

See Table 2 for the measurements of the basil plants' width in inches. The average growth in width for the synthetic group is the greatest at 6.6 inches. However, the average growth in width of 6 inches for the organic group is very close to the synthetic group. The average growth in width of 3.3 inches for the control group is about half as much as the pesticide experimental groups.

See Table 3 for the number of pests on the basil plants. Both of the organic and synthetic experiment groups had 0 pests on the basil plants during the two months they were being sprayed with pesticide and being observed. The control group with no pesticide had numerous pests all over the leaves, especially Pennu Lu.

See Photo 7 of control basil plant named Penny Lu with numerous insects and holes in the leaves. We observed the basil carefully to look for bugs and insects. The other control basil plants had many holes in their leaves.

See Photo 8 of synthetic pesticide basil plant named Ella Jr with no bugs or holes on its leaves, but has a white coating on its leaves.

See Photo 9 of organic pesticide basil plant named Emma Jr which has no bugs or holes on its leaves, and has very healthy looking, clean leaves. The leaves are very green with no white coating on them.

See Photo 10 of a team member using a microscope to observe, sketch, and identify insects from control basil plant named Penny Lu on 12/31/2015. See Photo 11 for a close up photo of the insects that we identified to be fruit flies.

DATA COLLECTION ON THE BEST TASTING BASIL

See Photo 13 showing the Basil Cello Scientists conducting a survey on our fellow students about the best tasting basil. On Jan 19, 2016, we had 50 people taste each of the different groups of basil we grew -- with synthetic pesticide, organic pesticide, and control had no pesticide. We asked our family, friends, and fellow students which basil they thought tasted the best. In the survey, we called the controlled basil number 1, the synthetic pesticide was number 2, the organic pesticide was number 3, and if someone thought they all tasted the same, they could choose number 4. We didn't tell the participants which basil was which so they weren't intimidated to choose a specific one. We also kept the survey anonymous by not telling any of our taste tester what others thought, so that they would not be influenced by their friends and peers.

See Chart 1 showing the results of the Best Tasting Basil Survey as a pie graph. In first place, 50% of the participants selected the control basil as the best tasting basil. In second place, 28% of the participants selected the organic basil as the best tasting basil. In third place, 18% of the participants selected the synthetic basil as the best tasting basil. Only 4% of the participants said they all tasted the same, and an observation about that group is the two people were brothers of the team members.

DATA COLLECTION ON THE EFFECT OF PESTICIDES ON WORMS

See Photo 12 of testing the effect of organic and synthetic pesticides on meal worms. On Jan 5, 2016, we bought 150 meal worms from a local pet store (these worms are sold as food for other animals) to see what would happen to the worms when they came into contact with or ate the basil leaves that we sprayed with the synthetic pesticide and organic pesticide.

Observation notes during the first 10 minutes after spraying pesticides:
1. The group of worms in the control group continued to crawl around and eat the basil leaves.
2. Most of the group of worms sprayed with synthetic pesticide were immediately wiggling around more frantically than usual. Then they would lift their heads up, then collapse into a U shape, and die.
3. The group of worms sprayed with organic pesticide immediately froze for about one minute. Then they moved around normally. At the five minute mark, they were moving around slower than usual and none of them were eating the basil leaves.

Observation notes over the next 6 days after spraying pesticides:
1. In the control group, the worms were crawling around and eating the basil leaves, but all died by the third day.
2. In the synthetic pesticide group, there were only 2 or 3 worms still moving and alive. By the end of the first day, all were curled up and dead.
3. In the organic group, the worms survived for 5 and ½ days. Some of the worms turned into beetles.

See Chart 2 for a bar graph of the effect of pesticides on worms. The worms sprayed with synthetic pesticide only survived one day or less. The worms sprayed with organic pesticide survived the longest at 5 1/2 days. The worms that were not sprayed with pesticide survived 3 days.

(11) Analyze the data you collected and observed in your testing. Does your data support or refute your hypothesis? Do not answer with a yes or no. Explain your answer using one of the following prompts: 'Our data supports/refutes the hypothesis because...'

DATA ANALYSIS

Our data supports our hypothesis because it showed the following:
1. The basil plants treated with organic pesticide were not destroyed by pests.
2. The basil plants treated with organic pesticide grew just as well in size and shape as the basil plants treated with synthetic pesticide.
3. The organic basil tasted better than the basil leaves sprayed with chemicals.
4. It is logical to conclude that the humans that eat the organic basil are not harmed by the toxic chemicals on the basil plants treated with synthetic pesticide because the humans did not ingest the toxic chemicals if they did not eat those basil leaves.

The data presented in photos 7 thru 11, and Table 3, show the control group has many pests on those basil plants, but the experimental group did not have any pests on those basil plants during the two months they were treated with organic and synthetic pesticides. The photos show the control group has been damaged and left with holes in the leaves of those basil plants. We did some further research and found out that slugs and snails were causing the larger round holes. Therefore, both the organic and synthetic pesticides were effective in preventing pests from destroying the basil plants. However, the basil plants that had no pesticide sprayed on them were damaged by pests identified to be fruit flies, slugs, and snails.

Table 1 shows that all of the basil plants grew significantly well in height during the two months of our experiment. The average growth in height of the control group grew the most at 14.1 inches. The organic basil plants grew an average of 13.6 inches in height, which is slightly more than the synthetic pesticide basil plants which grew an average of 13.1 inches in height. Therefore, the basil plants treated with organic pesticide are able to grow just as well in height as basil plants treated with synthetic pesticide or no pesticide at all.

Table 2 shows that the basil plants treated with pesticide grew about twice as wide than the basil plants not treated with pesticide during the two months of our experiment. The average growth in width of the control group grew the least amount at 3.3 inches. The organic basil plants grew an average of 6.0 inches in width, which is slightly less than the synthetic pesticide basil plants which grew an average of 6.6 inches in width. Therefore, the basil plants treated with organic pesticide are able to grow just as well in width as basil plants treated with synthetic pesticide and better than basil plants with no pesticide at all.

Photo 13 and Chart 1 show the results of the Best Tasting Basil Survey that we conducted on 50 students, teachers, family members, and friends. The results of this taste survey support our hypothesis because it proves that more people (28%) liked the organic basil better than the basil leaves treated with synthetic pesticide (18%). Even though most people in the survey liked the taste of the control group basil leaves the best (50%), those plants had been damaged from pests. It makes sense that most people like the true basil taste without anything additional sprayed on it whether it is toxic chemicals or tastes like garlic or peppers. It is normal that a small amount of the participants (4%) could not tell the difference in the taste of basil leaves. Therefore, the most important result of this survey is that people liked the organic basil better than the basil leaves that had been sprayed with synthetic pesticide.

Photo 12 and Chart 2 show the results of our secondary experiment on the effect of pesticides on worms. We tested how long worms could survive with the different pesticides sprayed directly on them in containers with air holes, and with basil leaves and bran for food. The worms with the synthetic pesticide sprayed on them survived the shortest amount of time from 1 minute to one day. The worms with organic pesticide sprayed on them survived the longest for 5 1/2 days. The worms with no pesticide sprayed on them survived for 3 days. Therefore, the toxic chemicals in the synthetic pesticide are very strong and effective in eradicating pests very quickly. We do not understand why the worms with no pesticide, not a single drop sprayed on them, did not survive longer than the other two groups since they were provided with food and air. The worms sprayed with the organic pesticide took about 5 times longer to die than the worms sprayed with synthetic pesticide.

Our research on neem oil helped to explain what was happening with these worms:

Neem enters the system and blocks the real hormones from working properly. Insects forget to eat, mate, and they stop laying eggs. The insects are too confused to eat or breed and will not survive. Neem works at very low concentrations, so a little neem goes a long way. The mere hint of a smell of neem oil seems to be enough to keep leaf eating insects away. This hormonal effect is the key to neem oil being an effective insecticide and good for the environment (Is It Safe to Spray Neem?).

Our observation of the worms that were sprayed with organic pesticide which included neem oil showed that after 5 minutes, the worms were moving around slower because they were confused. They stopped eating the basil leaves because their hormones had been changed and they forgot to eat. Therefore, it took 5 1/2 days for these worms to starve to death, and during that time, the basil leaves were not being destroyed.

(12) Explain any sources of error and how these could have affected your results.

Sources of error that could have affected our results for when we measured the basil is that the soil could have moved, making the plants seem taller or shorter than they actually are. When we sprayed pesticide on the basil plants some sources of error that may have affected our results is that we might have not added enough pesticide, or too little. Maybe the garden boxes were not receiving the same amount of sun because there is a large tree closer to the control group that might have caused shade on those basil plants and that caused them to not grow as wide as the others.

When we tested the worms survival, the amount of pesticide sprayed may have been uneven, causing one pesticide to work better, or maybe the synthetic pesticide blew into the container that was supposed to have no pesticide. Also, the air holes we poked into the containers might have been too small, therefore the worms may have suffocated instead of reacting to pesticide. We did not give the worms water, so maybe they died because of needing water instead of reacting to pesticide. We are uncertain about the accuracy of the results of this secondary experiment.

When we had a basil taste test some sources of error might have been that not all the contestants drank water after tasting each basil, so their taste buds might not have been cleared, or some of the contestants might not have ever tried basil before, or they generally don't like basil making it hard for them to choose which basil they liked the best. Some contestants may have been influenced to pick the same basil as their friends, or they weren't taking the taste test seriously.

Drawing Conclusions

(13) Interpret and evaluate your results and write a conclusion statement that includes the following: Describe what you would do if you wanted to retest or further test your hypothesis. Evaluate the usefulness of the data your team collected. What changes would you make to your hypothesis and/or experimental design in the future, if any?

EXPERIMENT PROVED HYPOTHESIS CORRECT

Our experiment was a success because we proved our hypothesis correct that organic pesticide works just as well as synthetic pesticide. The organic pesticide was overall better for the basil plants in many ways. One way is that the basil plants with the organic pesticide sprayed on them grew taller and about as wide as the basil with synthetic pesticide sprayed on it, see Table 1 and 2 for measurements of the basil plants. We also conducted a taste test survey that supported our hypothesis because more people liked the taste of the basil with the organic pesticide than the basil with the synthetic pesticide, but more people liked the basil with no pesticide. However, the control group basil with no pesticide sprayed on it had many insects and slugs that damaged the leaves. Our experiment proved our hypothesis correct that organic pesticide will keep the pests from destroying the plants.

To further test our hypothesis in comparing organic versus synthetic pesticide, we tested each pesticides effect on meal worms/beetles. Even though the toxic chemicals in the synthetic pesticide are very strong and effective in eradicating pests very quickly, the organic pesticide also eradicated the worms 5 days later. The most important point is that the basil leaves were not damaged during those 5 days. Our research on neem oil helped to explain what was happening with these worms:

Neem enters the system and blocks the real hormones from working properly. Insects forget to eat, mate, and they stop laying eggs. The insects are too confused to eat or breed and will not survive. Neem works at very low concentrations, so a little neem goes a long way. The mere hint of a smell of neem oil seems to be enough to keep leaf eating insects away. This hormonal effect is the key to neem oil being an effective insecticide and good for the environment (Is It Safe to Spray Neem?).

The worms stopped eating the basil leaves because their hormones had been changed by the neem oil and they forgot to eat. Therefore, it took 5 ½ days for these worms to starve to death, and during that time, the basil leaves were not being destroyed and did not end up with toxic chemicals on them.

USEFUL DATA LEAD TO NEW DISCOVERY AND SOLUTION

The data in our experiment is very useful because we discovered a low cost replacement for synthetic pesticide. We believe homemade pesticide of organic materials is the solution, and it will not harm humans and our environment. The "secret" ingredient in our homemade organic pesticide is NEEM OIL! Since none of us had heard about neem oil before, it was a new discovery for our group.

Neem is a key ingredient providing a natural alternative to synthetic pesticides. Neem seeds from the neem tree are ground into a powder that is soaked overnight in water and sprayed onto the crops. It needs to be reapplied at least every ten days. Neem does not directly kill insects on the crop, it acts as an anti-feedant, repellent, and egg-laying deterrent. This protects the crops from damage because the insects starve and die within a few days (Azadirachta indica).

See Table 4 for the Cost of Pesticide. Our homemade organic pesticide recipe is the least expensive at $.10 per ounce. We bought a 4 ounce bottle of neem oil for $5 with free shipping with Amazon Prime. Our recipe is for ½ teaspoon of neem oil to make a 16 ounce batch of pesticide. So a little neem oil goes a long way, and it is not expensive, and it is easy to buy.

We conclude that making organic pesticide yourself is the least expensive way to afford pesticide. For our homemade recipe, we used the retail price of the ingredients we used -- Hawaiian chili peppers, garlic, and neem oil, and the cost came out to $.10 per ounce. We understand that there are additional costs involved like the labor and time it takes to chop the vegetables yourself. Another idea to reduce the cost of organic pesticide is to grow the ingredients on your farm. Our research showed that all three ingredients of our recipe grow in Hawaii -- Hawaiian chili peppers all over Oahu and other islands, elephant garlic on Maui, and neem trees in Waimanalo.

INDEPENDENT AND DEPENDENT VARIABLES

The independent variable was the two different types of pesticides sprayed on the basil plants. It had a direct relationship with the dependent variable of how the basil plants reacted. Most noticeable is the taste of the basil leaves is much better with organic pesticide than with synthetic pesticide. The chemicals leave a bad taste on the basil leaves and it is hard to wash the pesticide off the basil (Kim, 2015). We could even see white residue left on the basil leaves after the synthetic pesticide dried. This supports our hypothesis that organic produce will taste better if it does not have toxic chemicals on it.

FUTURE IDEAS ON RETEST, CHANGE HYPOTHESIS, INTERVIEWS, BOTTLE OUR ORGANIC PESTICIDE

We would like to retest the secondary experiment of the effect of pesticides on worms. We would make sure each container for the worms has an equal amount of air holes that are big enough for the worms to breath, and we would make sure the amount of pesticide we sprayed was equal. We would also test a different kind of worm like an earthworm, or conduct the experiment on crickets.

We would like to conduct further tests on other fruits and vegetables like and strawberries and cucumbers. We would like to learn more about other crop management techniques like rotating crops at certain seasons and using beneficial pests to rid the harmful pests.

Next time, if we were to do another experiment we would change the hypothesis by also testing the soil and water. We would try to get access to a laboratory to test soil and water under the soil for toxic chemicals. This would give us more information about pesticide runoff and pesticide drift. Also, we would be learning more of the complex chemical names used in synthetic pesticide.

We would like to continue this project in the future. One idea is to manufacture and sell our homemade organic pesticide recipe. See Photo 19 of a spray bottle with our homemade organic pesticide with cool marketing using our Basil Cello Scientist logo. We would also test different recipes focusing on neem oil. We would try growing the ingredients ourselves.

If we had more time, we would be able to follow-up with our attempts to interview people with significant information about farming -- Ms. Greenaway the president of Hawaii Organic Farming Association, Mr. Paul Towers of the Pesticide Action Network, and the non-organic farmers (see Interview 3 questions).

CONCLUSION

In conclusion, our hypothesis was correct that organic pesticide is better than synthetic pesticide in growth of plants, taste of produce, in repelling pests, and in being safer for humans and our environment. This experiment is a possible solution to the community problem of toxic chemicals in synthetic pesticide harming humans, animals, and our environment in Hawaii.

The chemicals in synthetic pesticide are harmful to humans. It can lead to serious health issues such as cancer, reproductive dysfunction, diabetes, autism, birth defects, and Alzheimer's disease (Wide Range of Diseases Linked to Pesticides, 2010).

Farmers should stop using synthetic pesticide and switch to homemade organic pesticide with neem oil to prevent pests from damaging their plants. Then farming will be less harmful to animals, farmers, and their families, and it will still work the same or better on eradicating pests. Also, the organic produce will grow and taste better than the produce with synthetic pesticide on it.

This experiment is a valid solution to farming because it proves organic pesticide works just as well as synthetic pesticide in protecting the plants from being damaged by pests. The farmers can use organic pesticide and not have a decrease in their yield or harvest. Another idea is to grow the ingredients (Hawaiian chili peppers, garlic, neem trees) on their farm, so it will be less expensive than purchasing organic pesticide from retail stores.

The results of this experiment are a step in the right direction for preserving our environment and leading to a more sustainable, healthy future for everyone.

Uploaded Files:

- [View] **Chart 1** (By: basilcello2, 02/06/2016, .pdf)
  Best Tasting Basil Survey
- [View] **Photo 2** (By: basilcello2, 02/06/2016, .JPG)
  10/31/15 Planting basil seeds in organic soil with organic fertilizer.
- [View] **Photo 3** (By: basilcello2, 02/06/2016, .JPG)
  11/28/15 The Basil Cello Scientists are planting 9 organic basil seedlings in organic soil with organic fertilizer in 3 separate containers to be the control, synthetic pesticide, and organic pesticide.
- [View] **Photo 4** (By: basilcello2, 02/06/2016, .JPG)
  11/28/2015 Measuring the basil seedlings before applying the pesticide.
- [View] **Photo 5** (By: basilcello2, 02/06/2016, .JPG)
  Making the organic pesticide from garlic, Hawaiian chili peppers, neem oil, and water in a blender.
- [View] **Photo 6** (By: basilcello2, 02/06/2016, .JPG)
  Once a week, we sprayed synthetic pesticide on the middle container of 3 basil plants and organic pesticide on the right container of 3 basil plants. We did not spray anything on the left container of 3 basil plants. We used protective gloves and held up a plastic bag as a blocking divider between the containers so the pesticide did not blow on the other plants.
- [View] **Photo 7** (By: basilcello2, 02/06/2016, .JPG)
  12/29/2015 Control basil plant named Penny Lu has many insects all over the basil plant and its leaves had holes eaten in them.
- [View] **Photo 8** (By: basilcello2, 02/06/2016, .JPG)
  12/29/2015 Synthetic pesticide basil plant named Ella Jr has no bugs or holes in its leaves, but has a white coating on its leaves.
- [View] **Photo 9** (By: basilcello2, 02/06/2016, .JPG)
  12/29/2015 Organic pesticide basil plant named Emma Jr has no bugs or holes in leaves and has very healthy looking, clean leaves.
- [View] **Photo 10** (By: basilcello2, 02/06/2016, .JPG)

Using a microscope to observe, sketch, and identify insects from control basil plant named Penny Lu on 12/31/2015.

- [View] **Photo 11** (By: basilcello2, 02/06/2016, .JPG)
  Insects found on control Penny Lu on 12/31/2015.
- [View] **Photo 12** (By: basilcello2, 02/06/2016, .JPG)
  1/5/2016 Testing organic and synthetic pesticides effect on meal worms.
- [View] **Photo 13** (By: basilcello2, 02/06/2016, .JPG)
  1/19/2016 Best tasting basil survey of students at our school.
- [View] **Photo 14** (By: basilcello2, 02/06/2016, .JPG)
  1/24/2016 We measured the growth of each basil plant's height and width every 2 to 3 weeks. The last measurement was after applying pesticide for two months.
- [View] **Photo 15** (By: basilcello2, 02/06/2016, .JPG)
  1/24/2016 After our experiment was completed, we harvested the basil leaves from the organic pesticide and control containers. We used the basil to cook pesto pasta sauce on ravioli. It was delicious! We felt good knowing that the basil was clean and healthy without chemicals.
- [View] **Newspaper 1** (By: basilcello2, 02/10/2016, .pdf)
  12/4/2015 "Pesticide damage found in kids of farmworkers"
- [View] **interview 1** (By: mrplurp, 02/13/2016, .pdf)
  11/11/2015 Interview with Mr.Zuckerman, owner of Kahumana Farm in Waianae, Hawaii.
- [View] **Photo 1** (By: Memma808, 02/13/2016, .jpg)
  11/11/2015 Excursion to Kahumana Farm, an organic farm in Waianae, Hawaii.
- [View] **Chart 2** (By: basilcello2, 02/16/2016, .pdf)
  The effect of pesticides on worms
- [View] **Table 3** (By: Memma808, 02/17/2016, .pdf)
  Number on Pests on Basil
- [View] **Interview 2** (By: Memma808, 02/17/2016, .pdf)
  2/15/2016 Interview of Kellie GutheilLee of HerbCo International Farm Coordinator, Waianae Hawaii
- [View] **Resources** (By: mrplurp, 02/18/2016, .pdf)
  List of resources used by Basil Cello Scientists research and grouped by category.
- [View] **Bibliography** (By: basilcello2, 02/20/2016, .pdf)
  Bibliography -- List of resources used by Basil Cello Scientists
- [View] **Table 1** (By: Memma808, 02/20/2016, .pdf)
  Basil Height Growth
- [View] **Table 2** (By: Memma808, 02/20/2016, .pdf)
  Basil Width Growth
- [View] **Table 4** (By: basilcello2, 02/22/2016, .pdf)
  Cost of pesticide per 1 ounce.
- [View] **Table 5** (By: basilcello2, 02/22/2016, .pdf)
  Price of basil for 1 ounce.

Community Benefit

(1) How could your experiments and data help solve your problem and benefit your community? Describe next steps for further research/experimentation and how you have or how you could implement your solution in the future.

OUR EXPERIMENT CAN HELP SOLVE THE PROBLEM AND BENEFIT THE COMMUNITY
We identified a community problem that 98% of the farms in Hawaii are using synthetic pesticide on their crops. Research has shown that the chemicals in synthetic pesticide can lead to serious health issues like cancer, diabetes, and birth defects. How do we stop synthetic pesticide from harming humans and our environment in Hawaii? DON'T PANIC, GROW ORGANIC!

Our experiment can significantly impact our community problem of pesticide poisoning because we proved that organic pesticide works just as well as synthetic pesticide in preventing pests from damaging the crops, the produce tastes better, grows well in size, and is better for your health by not consuming toxic chemicals. Our research and data help solve the community problem of pesticide poisoning because we found a low cost replacement for synthetic pesticide. We believe homemade pesticide made from organic materials is the solution, and it will not harm humans and our environment. If farmers can grow the ingredients then it will be less costly for them than purchasing organic pesticide from retail stores, because they have all the ingredients they need right there on their farm. Our research showed that all three ingredients of our recipe grow in Hawaii -- Hawaiian chili peppers all over Oahu and other islands, elephant garlic on Maui, and neem trees in Waimanalo.

It will benefit the entire community of Hawaii if farmers stop using synthetic pesticides with chemicals and switched to organic pesticide. First of all, the farmers and their families would not have to breath the toxic chemicals. Second, the people of Hawaii that are buying and eating those produce will be healthier by not ingesting the toxic chemicals that cause serious health issues. Third, our environment will be preserved for the future generations that need the land and water to be clean to sustain life.

NEXT STEPS FOR RESEARCH AND EXPERIMENTATION
We would like to conduct further tests of the effects of different pesticides on other fruits and vegetables like strawberries and cucumbers. We would like to learn more about other crop management techniques like rotating crops at certain seasons and using beneficial pests to rid the harmful pests.

We would like to test the soil and water in each of the 3 garden boxes of our experiment. We would try to get access to a laboratory to test soil and water under the soil for toxic chemicals. This would give us more information about pesticide runoff and pesticide drift. Also, we would be learning more of the complex chemical names used in

synthetic pesticide.

We would follow-up with our attempts to interview people with significant information about farming -- Ms. Greenaway the president of Hawaii Organic Farming Association, Mr. Paul Towers of the Pesticide Action Network, and the non-organic farmers. We want to learn more about the challenges in farming and hopefully convince farmers to switch to organic pesticide.

HOW WE IMPLEMENTED OUR SOLUTION

See Photo 16 of our poster titled “DON’T PANIC, GROW ORGANIC”. Also see Photo 17 on 2/16/2016, we presented our poster with results of our ECyberMission project on the environment to our classmates. This poster shows the results of our science project growing basil with synthetic versus organic pesticide. It shows that organic basil grew big and healthy and did not have damaged leaves like the control group which had no pesticide. We used this poster to inform and teach our fellow students that participated in the Best Tasting Basil survey that most of them chose the organic basil tasted better than the basil with chemicals on it. We pointed out that they should ask their parents to buy organic fruits and vegetables from now on. If all of us buy organic, then the farmers will meet the demand by growing and supplying more organic produce to consumers. Maybe the price of organic produce will then become lower if the farmers are able to buy organic pesticide in larger bulk at lower cost expenses to their farming business or maybe the farmers can grow the ingredients and make the organic pesticide themselves.

See Photo 18 of the materials we assembled to give to 3 non-organic farms that are near the Kahumana organic farm in Waianae. The blue booklet has printouts of our graphs and tables of our results and conclusions. We will also give each farmer a sample spray bottle of our homemade organic pesticide with neem oil in it. See Photo 19 for a closeup of the spray bottle that is decorated with our cool Basil Cello Scientist logo. The father of one of our teammates works in the farming industry and will distribute these materials for us.

See attached Map which shows an aerial view of the Kahumana organic farm and the surrounding farms that use synthetic pesticide. You are able to see that the other farms are very close to Kahumana. When they spray synthetic pesticide the wind blows the toxic chemicals to Kahumana farm and endangers their organic produce. Also the farm workers can feel the pesticide presence because they get itchy eyes. We will distribute our booklet on results and sample organic spray to 3 of these farms near Kahumana.

IMPLEMENT OUR SOLUTION IN THE FUTURE

We would like to continue this project in the future. One idea is to manufacture and sell our homemade organic pesticide recipe. See Photo 19 of a spray bottle with our homemade organic pesticide with cool marketing using our Basil Cello Scientist logo. We would also test different recipes focusing on neem oil. We would try growing the ingredients ourselves. If we can make organic pesticide affordable and accessible to farmers, then why wouldn’t they use it instead of poisoning the people and environment of Hawaii?

Our poster and an extra booklet are ready in case we are asked to present the results of our experiment to farmers or students. We are ready to spread the word -- DON’T PANIC, GROW ORGANIC!

ANALYSIS: COST OF PESTICIDE AND PRICE OF BASIL

We are trying to convince farmers to transition to organic production to benefit people’s health and the environment. How can we motivate them to change?

1. Protect the environment from toxic chemicals so you can keep farming that soil.
2. Live a long and healthy lifestyle by eating food without toxic chemicals and drinking clean water.
3. Organic certified crops command higher prices for those produce and that might justify the higher cost of farming organic, and might net a higher profit for your business.

Farmers need to evaluate the economic potential of the cost of organic farming and the organic price premiums. They need to fairly weigh the benefits and challenges of organic farming. We need more studies on cost and return for a variety of different organic and non-organic crops (Post, 2012). We conducted our own study and collected data on prices and costs as explained below.

See Table 4 for the cost of pesticides per ounce. We gathered the costs of both organic and synthetic pesticides and compared them by cost per ounce. We gathered the costs at a retail store and the cost that farmers would pay to buy in bulk from a retail store (see Interview 2, Gutheil-Lee, 2016). We conclude that making organic pesticide yourself is the least expensive way to afford pesticide. For our homemade recipe, we used the retail price of the ingredients we used -- Hawaiian chili peppers, garlic, and neem oil, and the cost came out to $.10 per ounce. We understand that there are additional costs involved like the labor and time it takes to chop the vegetables yourself. Another idea to reduce the cost of organic pesticide is to grow the ingredients on your farm. Our research showed that all three ingredients of our recipe grow in Hawaii -- Hawaiian chili peppers all over Oahu and other islands, elephant garlic on Maui, and neem trees in Waimanalo.

See Table 5 for the price of basil. We gathered the price of both organic and non-organic basil at 4 different retail stores. From the interview with Kellie Gutheil-Lee of Herbco International Farms, we were told that her company wholesales their organic Thai basil for $1.25 in a .75 ounce container, which is $1.67 per ounce, to the 4 retail stores listed in Table 5. We were able to find out from a Safeway employee that the wholesale price of basil from non-organic farmers to retail stores is $.37 per ounce. It is interesting to learn the grocery stores markup the prices of basil about 200% to 400%. Safeway sells organic basil for 266% higher than non-organic basil. Foodland sells organic basil for 560% higher than non-organic basil. We conclude that the retail price for organic basil is at least 2 times more than non-organic basil, and the wholesale price for organic basil is at least 4 ½ times more than non-organic basil. Therefore, since the farmers can wholesale the organic produce to grocery stores at a much higher price than the wholesale price for non-organic produce, this might justify the additional cost and labor to change to organic farming.

Uploaded Files:

- [**View**] **Photo 16** (By: basilcello2, 02/16/2016, .JPG)
  DON'T PANIC, GROW ORGANIC -- Poster showing the results of our science project growing basil with synthetic, organic, and no pesticide.
- [**View**] **Photo 17** (By: basilcello2, 02/16/2016, .JPG)
  2/16/2016 We presented our poster with results of our ECyberMission project to our classmates. For the Best Tasting Basil survey, most of the students chose the basil that had organic over synthetic pesticide.
- [**View**] **Photo 18** (By: basilcello2, 02/16/2016, .JPG)
  DON'T PANIC, GROW ORGANIC -- Booklet of our science project results with conclusion and a sample spray bottle of our home made organic pesticide will be given to 3 farms close to Kahumana organic farm to persuade them to switch to organic pesticide.
- [**View**] **Photo 19** (By: basilcello2, 02/16/2016, .JPG)
  Sample spray bottle of organic pesticide home made by the Basil Cello Scientists.
- [**View**] **Interview 3** (By: mrplurp, 02/18/2016, .pdf)
  Interview questions for farmers that use non-organic pesticide.

- [View] **Map** (By: Memma808, 02/24/2016, .pdf)

  Map of Kahumana Organic farm and surrounding non-organic farms

Mission Verification

(1) Does your Mission Folder project involve vertebrate testing, defined as animals with backbones and spinal columns (which include humans)? If yes, team must complete and attach an IRB approval form.

No

(2) Did your team use a survey for any part of your project? If yes, team must complete and attach a survey approval form.

Yes

(3) You will need to include an abstract of 250 words or less. As part of the abstract you will need to describe your project and explain how you used STEM (Science, Technology, Engineering and Mathematics) to improve your community

How do we stop synthetic pesticides from harming humans and our environment in Hawaii? DON'T PANIC, GROW ORGANIC!

Our team wanted to solve the community problem of pesticide chemicals harming people and our environment. We made organic pesticide and tested the effects on basil. We compared the results to bail sprayed with synthetic and with no pesticide. Our data shows that organic works just as well as synthetic pesticide in preventing pests from damaging crops, organic produce tastes better and grows well in size, and is better for your health by not consuming toxic chemicals.

Our experiment can help solve the problem of pesticide poisoning because we found a less expensive replacement for synthetic pesticide. The solution is homemade organic pesticide. The "secret" ingredient in our organic pesticide is NEEM OIL! To further reduce the cost of organic pesticide, farmers can grow the ingredients on their farms.

In the future, we want to manufacture and sell our homemade organic pesticide. If we make organic pesticide affordable and accessible to farmers, then why wouldn't they use it instead of poisoning the people and environment of Hawaii?

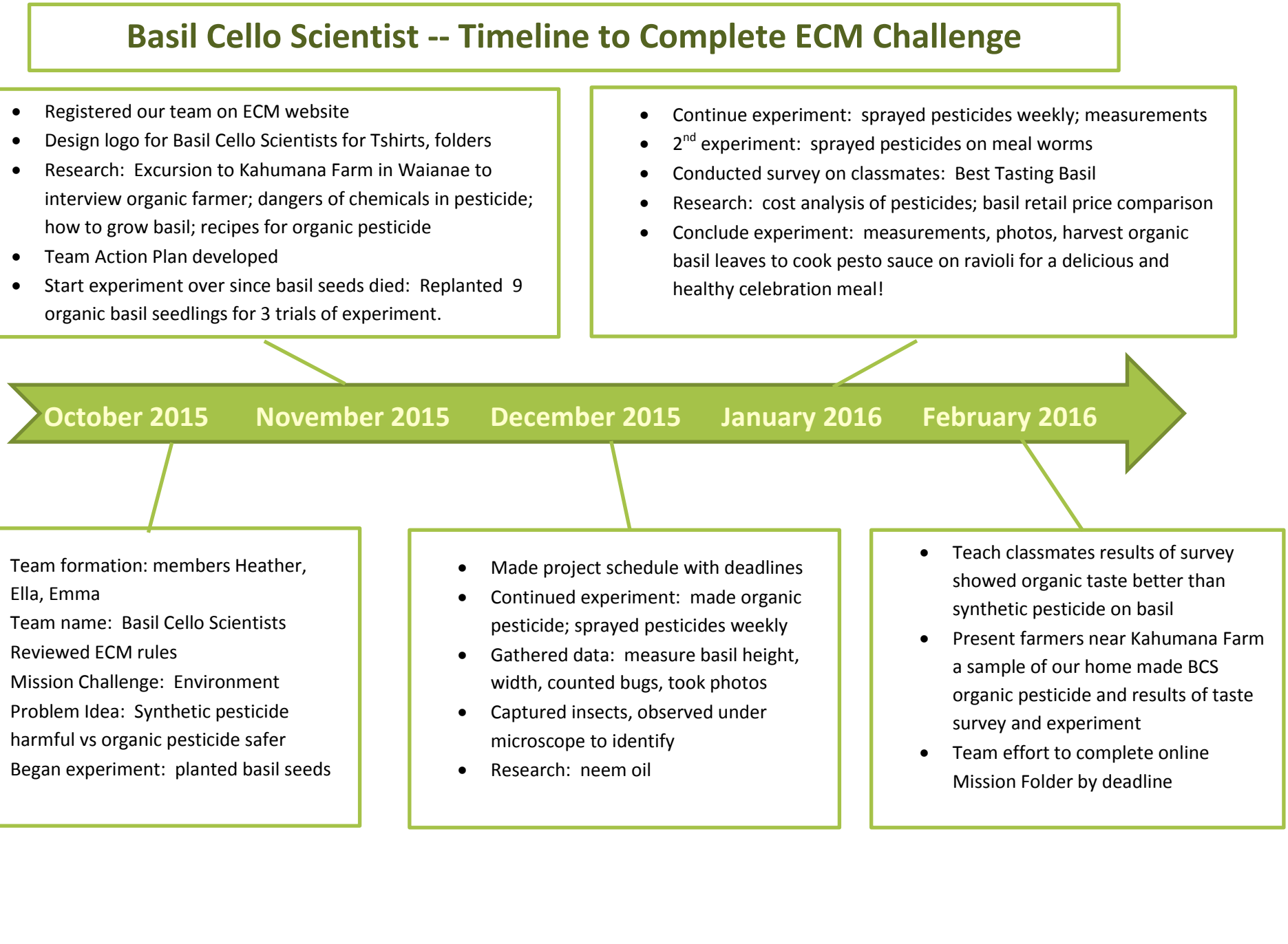
We used STEM to improve our community through agriculture, chemistry, measurements, and a microscope. We used computers for internet research, and programs to make tables and graphs. We used math to calculate the differences in measurements and averages of growth, price differences of wholesale and retail per ounce for organic and non-organic basil, and compared the cost of different pesticides reduced to one ounce.

Uploaded Files:

- [View] **Survey Approval Form** (By: basilcello2, 02/09/2016, .pdf)

  Survey Approval Form signed by Principal Ed Noh for best tasting basil taste test conducted on students on Jan 19, 2016.

Basil Cello Scientist -- Timeline to Complete ECM Challenge



BASIL CELLO SCIENTISTS – TEAM ACTION PLAN

TASK	TEAM MEMBER	DUE DATE
Create new Google Drive ECyberMission Folder shared with team	Heather	10/28/15
Review ECM rules	Emma, Heather, Ella	10/28/15
Science project topic ideas	Emma, Heather, Ella	10/28/15
Select team name	Emma, Heather, Ella	10/28/15
Research how to grow basil	Ella, Heather	11/4/15
Plant basil seeds	Heather	11/4/15
Logo design for Basil Cello Scientists	Heather	11/4/15
Research synthetic pesticides harmful to humans and animals	Ella	11/4/15
Schedule excursion to Kahumana organic farm	Emma	11/4/15
Write questions to interview farmer Zuckerman	Emma, Heather, Ella	11/4/15
Write questions to interview non-organic farmers	Emma, Heather, Ella	11/4/15
Register on ECM website	Emma, Heather, Ella	11/4/15
Order Tshirts w/BCS logo	Heather	11/9/15
Excursion to Kahumana Farm	Emma, Heather, Ella	11/10-11/15
Obtain organic pesticide recipe	Emma, Heather, Ella	11/11/15
Research organic certification in Hawaii	Heather	11/25/15
Research cases of humans or animals harmed by pesticide	Ella	11/25/15
Research neem oil	Heather	11/25/15
Research pesticide on worms	Emma, Heather	11/25/15
Transcribe interview with Farmer Zuckerman	Emma	11/25/15
Plant 9 basil seedling plants, photos, measurements	Emma, Heather, Ella	11/28/15
Make organic pesticide batch	Heather, Ella	12/5/15
Spray organic and synthetic pesticide on basil weekly	Emma, Heather, Ella	1/24/16

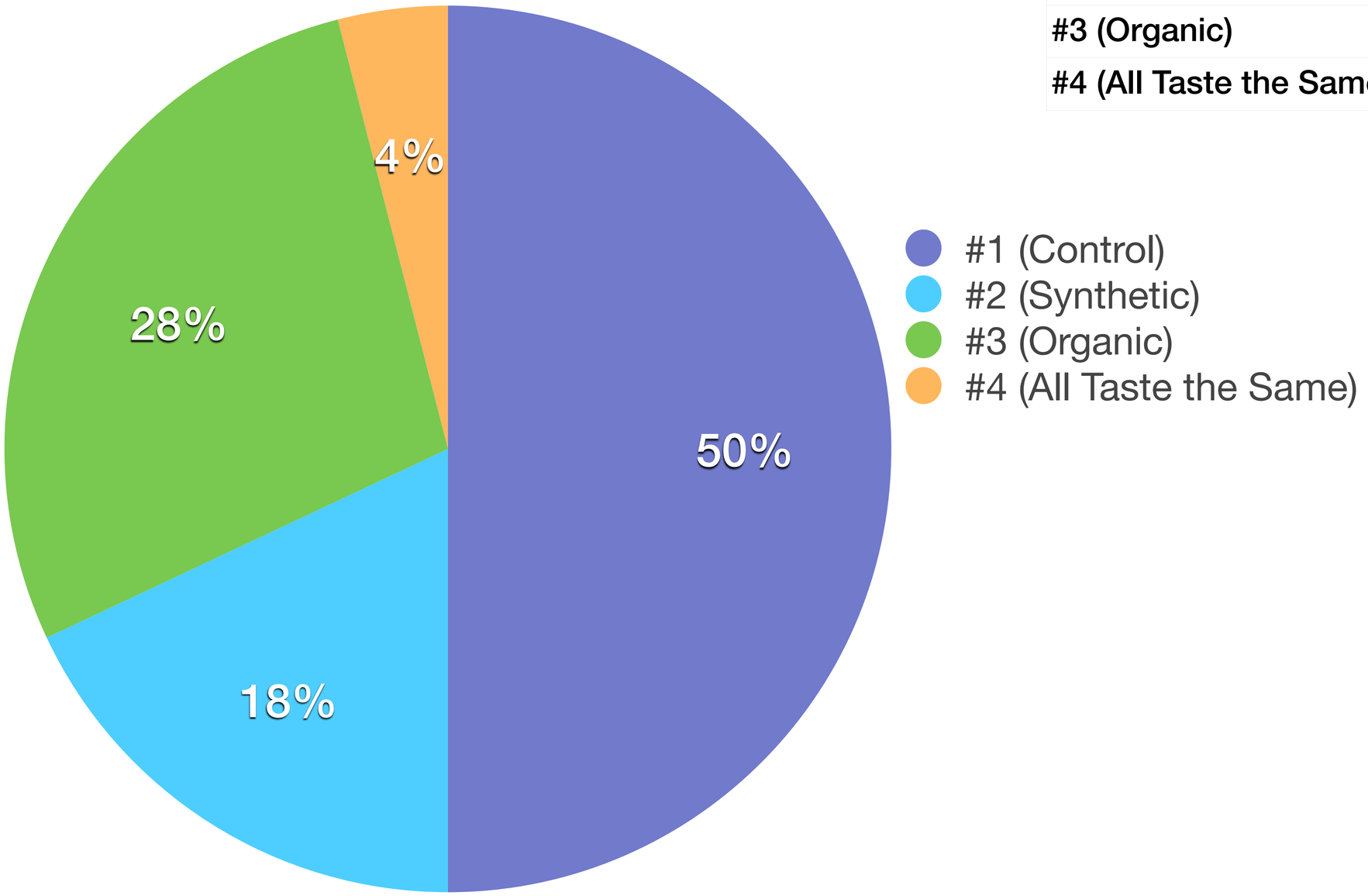
Take photos of basil and measurements every 2-3 weeks	Emma, Heather, Ella	1/24/16
Conduct experiment on meal worms by spraying synthetic and organic pesticide on them and observing reaction	Emma, Heather, Ella	1/5/16
Capture insects on basil leaves	Heather	1/12/16
Observe insects under microscope to identify	Emma, Heather, Ella	1/13/16
Conduct survey of best tasting basil on classmates	Emma, Heather, Ella	1/19/16
Conclude experiment with final photos, measurements, harvest organic basil leaves to cook pesto sauce	Emma, Heather, Ell	1/24/16
Login to ECM Mission Folder to understand the process to input answers, upload attachments, and save.	Emma, Heather, Ella	1/27/16
On ECM rubric, volunteer to be responsible in answering specific questions on Mission Folder	Emma, Heather, Ella	1/27/16
Interview questions to Basil Lady regarding wholesale prices for cost analysis	Heather, Emma	2/5/16
Create tables of basil measurements of height and width	Emma	2/6/16
Create pie chart of survey results of best tasting basil	Heather	2/6/16
Upload 15 photos with descriptions	Heather	2/6/16
Using map, locate organic farm and surrounding non-organic farms	Ella	2/13/16
List resources in Bibliography	Emma, Heather, Ella	2/19/16
Teach classmates results of survey showed organic tastes better than synthetic pesticide on basil	Emma, Heather, Ella	2/19/16

Present non-organic farmers near Kahumana organic farm a sample of BCS home made organic pesticide and results of taste survey and experiment	Emma, Heather, Ella	2/26/16
Input answers to questions in the ECM Mission Folder and upload attachments	Emma, Heather, Ella	2/29/16

BASIL CELLO SCIENTISTS – TEAM RESPONSIBILITIES

EMMA	HEATHER	ELLA
Lead spokesperson for survey, presentations	Artistic designed logo, poster	Gardening experience
Computer Wiz	Photographer	Researcher
In charge of worms	Cooking skills for snacks and recipe for organic pesticide	Writing skills
Leadership skills	Creative	Creative
Competitive spirit encouraged and motivated others	Basil care and maintenance	Encourages others to persevere
Communicate with farmers	Writing skills	Critical thinker
Writing skills	Capture insects and identify under microscope	Topography
Analyst	Analyst	Analyst
Family works in farming industry	Coordinates team meetings	Good listener and cooperative
Bilingual English/Chinese to speak with farm workers	Mathematician	Note taker, data collector
Innovator	Prepare pie graph, timeline, and charts	Works together well with everyone
Problem solver	Encourages team with food	Prepared results in booklet for farmers

Basil Taste Test



Best Tasting Basil Survey

BASIL	VOTES
#1 (Control)	25
#2 (Synthetic)	9
#3 (Organic)	14
#4 (All Taste the Same)	2

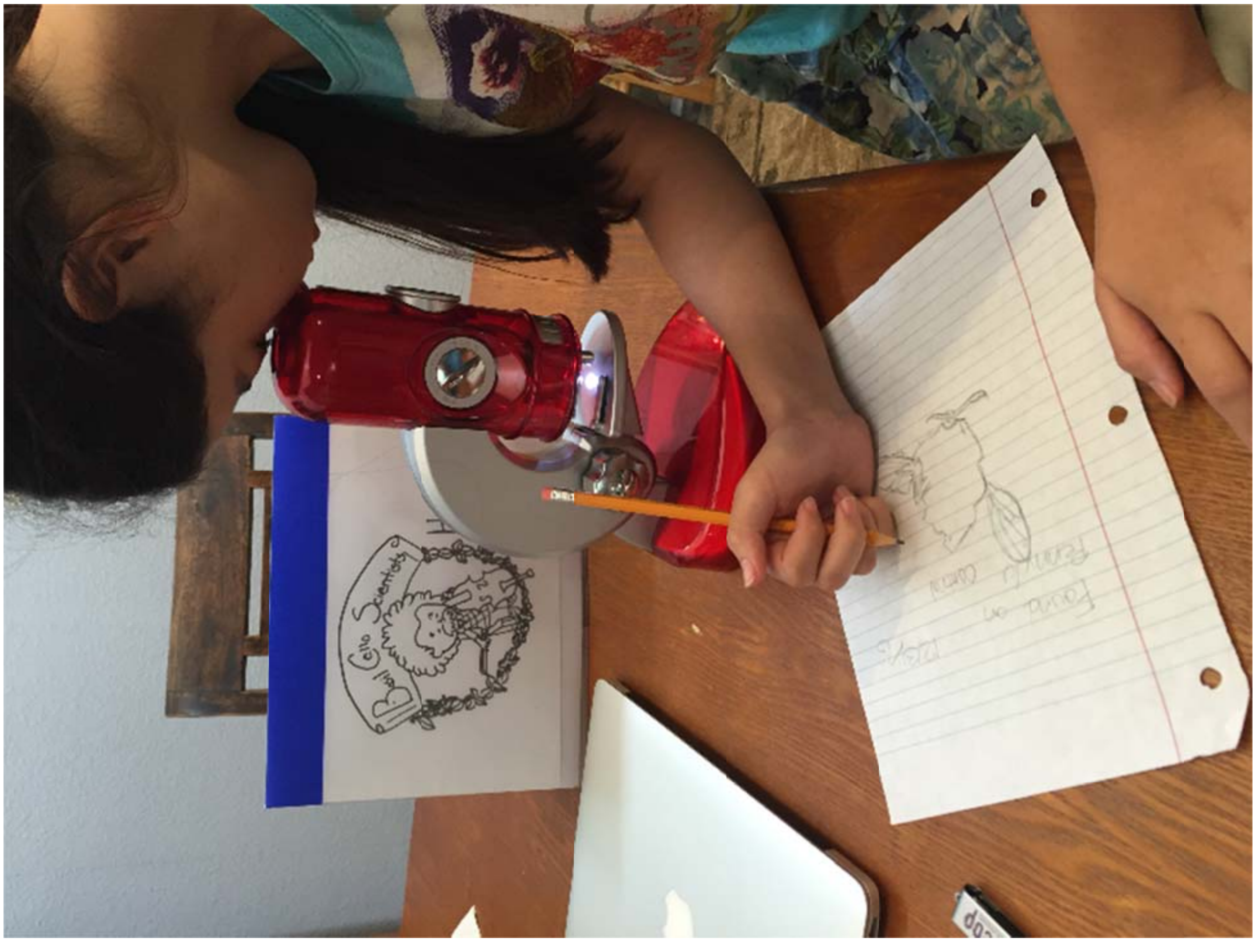

G&B
ORGANICS
Potting
Soil
Potting Soil
BURPEE


pyrex


Controlled
Pennywort


Synthetic
Ella 5F.


Organic
Emma's




Synthetic Pestiside
"Organic Pestiside!"


SALE

Pesticide damage found in kids of farmworkers

By Geoffrey Mohan
Los Angeles Times

Chronic exposure to pesticides can damage children's lung function by about as much as secondhand cigarette smoke does, according to a study of farmworkers' children in the Salinas Valley of California.

The long-term study of 279 children from farmworker families is the first to suggest that even being one step removed from pesticides can bring harm to children's lungs. Previous studies examined effects on adults who spray the chemicals or work in fields where the pesticides are applied.

"This is really the first time that it's a residential population, and a residential population of children," said study co-author Brenda Eskenazi, an epidemiologist at the University of California, Berkeley.

The children have been followed since birth as part of a broader study that began about 15 years ago with 601 pregnant women in the Salinas Valley, conducted by the Center for the Health Assessment of Mothers and Children of Salinas.

Previous studies from that group have turned up correlations between organophosphate exposure to pregnant women and shorter-duration pregnancies, diminished reflexes in their babies,and lower cognitive function in older children. Organophosphates are a class of chemicals found in about three dozen pesticides registered for agricultural use in the U.S.

In the current study, published online Thursday in the journal Thorax, pregnant women were tested for chemicals in their urine that come from metabolizing organophosphates. Their children were tested at five intervals, from 6 months of age to 5 years, then were given a series of exhalation-measuring tests at age 7.

The researchers found a significant correlation between lower exhalation rates — roughly equivalent to about 8 percent less air — and higher levels of organophosphate metabolites. The decrease in lung function was similar to the declines chronicled in a well-known 1983 study of prolonged exposure to secondhand cigarette smoke.

No correlation was found between prenatal exposure and the diminished lung capacity.

Half of the women in the study had worked in agricultural fields, while about 84 percent of the families included at least one adult agricultural worker, Eskenazi said.

How the children may have been exposed is unclear. "It's likely that some of the exposure is coming through the air, and a lot of the exposure is coming from food or other hand-to-mouth behavior, through ingestion," Eskenazi said.

Researchers controlled for factors such as asthma, smoking, exposure to particulate matter and a variety of demographic indicators.

"Of course, one study doesn't ever say everything," Eskenazi said. "You always have to confirm it with other studies."

Sun Advocate 12-4-2015
B2

QUESTIONS FOR FARMER THAT USES ORGANIC PESTICIDE
Farmer Name: __Christian Zuckerman___
Farm's name and address: Kahumana Organic Farm and Cafe

_____
Date: _11/11/15__ Student Names: Emma, Heather, and Ella

1. Is non-organic pesticide a community problem? How?
Does it harm people, animals, other plants?
"Yes, when it is windy, there's blow over. If you have asthma you get very irritated. Everyone get itchy eyes. People aren't happy about the non-organic pesticides. Run off gets on organic land, and organic farms can lose their title as an Organic Farm."

2. Where do you get your basil seeds? "Johnny's Selective Seeds."

Do you use organic fertilizer? "Yes, we make our own compost. We use chicken manure and foliar sprays, and broken down fish."

How much water do you use to water basil? "Doesn't need much water. We give it about five gallons per week."

How much sun does it need? "Basil likes full sun. That's why it does so well here in Waianae."

3. What type of insects are you trying to keep off the basil? Biggest problems are the Mealy bug and the spittle bug. Some diseases basil gets are Powdery Mildew and Black Mold.

At what point in growing basil do you start spraying the pesticides? "We used to just do it as needed, but we found out that we need to spray on a weekly basis."

How do you apply the pesticide? "Backpack sprayer. You just put all the ingredients into the backpack, put it on and, then spray the plants. "

4. Do organic pesticides work as good as regular pesticides? "Ya. It's just that you have to be more persistent. The chemical ones are more effective for short term because they keep the bugs away more easily, but in the long term organic pesticides are better for the plant, and for the person who will be eating it."

What brand of organic pesticide do you use on basil? Where do you buy it? "We use two kinds for our basil. We use PyGanic, which is made from the Cerinthianism flower, and we get

that one from Pacific Agricultural Suppliers. The other one we use is Grandevo, also from the Pacific Agricultural Suppliers."

Or do you make it yourself? Recipe? "We also make our organic pesticides using neem, hawaiian chili peppers, and garlic. We take it all, huck in all into a big Vitamix, and blend it into a big green 'smoothie', and put it into the big backpack sprayers. And then we take that, sort of strain it to get all of the pulp out, and that's like the concentrated pesticide that we put into the backpack sprayer."

5. Do you sell more or less basil than farmers that use non-organic pesticide? "Less"

Which stores do you sell to? Is it marked organic?

How much higher is the cost of organic basil than non-organic basil? "We're selling ours at about $12 per pound, but of course it is less expensive in stores."

6. Are you afraid that the neighboring pesticides will blow or wash on top of your basil plants and animals and people/workers? How can you tell this is happening? "Definitely the blow over. We get that all the time. You can definitely tell when it's coming our direction. It's definitely an issue. It could eventually jeopardize our Organic status, because that is one of the things that when you become certified organic that they [the state] looks at. As far as run-off, luckily we are on the high grounds, so we don't get so much flooding. "

7. If inspectors come and see non-organic pesticide on the plants, can you lose your organic certification? "I believe here at Kahumana there has only been one time in our history that a farmer has used chemical pesticides. But besides that, we here have always been very careful about what we spray, and we always use organic methods and practices."

8. Do you have other concerns about basil and pesticide? "Well, there's a lot of issues about non-organic pesticides, like all sorts of health issues, but then there are also some environmental impacts, like all those pesticides getting into the air, doing all sorts of harm, and most of those pesticides not only kill the bad bugs, but the good ones too, like ladybugs, earthworms, things like that. And then the fertilizer, the chemical fertilizer, things that not only affect the plants, but then also sink into the soil, and gets into our water table, and when we go to drink water, it gets into us."

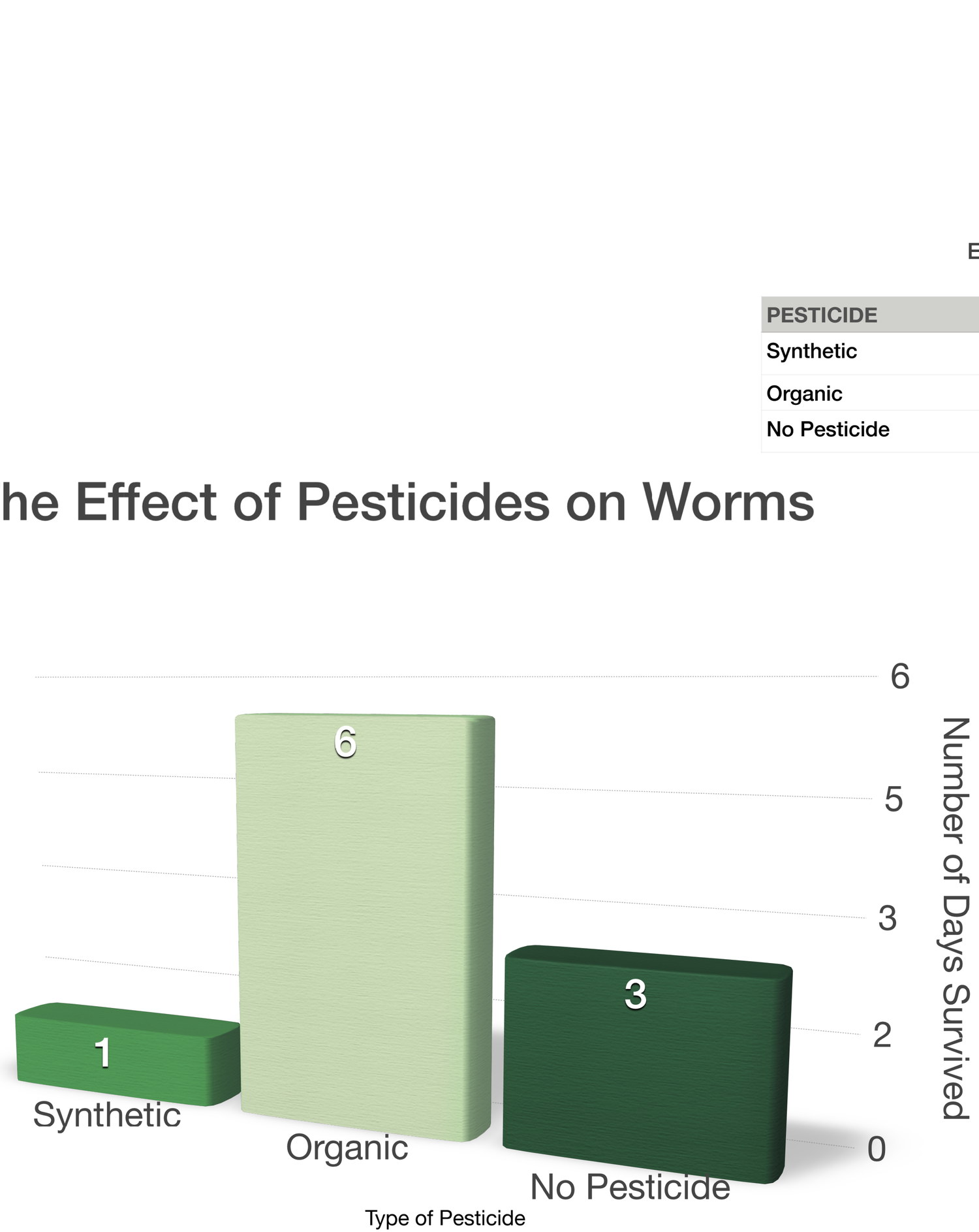
9. May we present the results of our experiment to you around February? "Yes, I would love to see the outcome!"

Thank you very much for your time and cooperation with this interview for our science project.

The Effect of Pesticides on Worms

Effect of Pesticides on Worms

PESTICIDE	NUMBER OF DAYS SURVIVED
Synthetic	1
Organic	5.5
No Pesticide	2.5



Number of Pests on Basil

Name Of Plant	11/28/2015	12/13/2015	1/5/2016	1/24/2016
Organic Petunia	0	0	0	0
Organic Chewy	0	0	0	0
Organic Emma Jr.	0	0	0	0
Synthetic Joe	0	0	0	0
Synthetic Ella Jr.	0	0	0	0
Synthetic Ella Jr. II	0	0	0	0
Control Bob	0	0	7	8
Control Mo	0	0	8	10
Control Penny Lu	0	10	70	50

2/15/2016 Interview of Kellie Gutheil-Lee of HerbCo International
Farm Coordinator, Waianae Hawaii
516-721-1749, Kellie@Herbco.net

Questions regarding price of basil:

What is the wholesale price of organic basil to grocery stores? "$1.25 for .75oz (this is not what the stores sell it for)"

What is the wholesale price of non-organic basil to grocery stores? "Sorry we only sell organic"

Is the higher price of organic vegetables enough to motive a farmer to become organic certified? "No"

Which stores do you wholesale basil to? "Wholefoods, Times, Safeway, Foodland"

Do you sell more or less basil than farmers that use non-organic pesticide? "Currently we are largest herb growing on Oahu, as per the USDA"

Our research at 3 different grocery stores shows the retail price of organic basil to be $3.99/ounce and retail price of non-organic basil to be $2.99/ounce, which is 30% higher price of organic basil. Is the higher price by 30% for organic about the same for other vegetables? "No. Herbs are easier to grow organic, while say sweet peppers are very difficult to grow due to too many bug related issues so the cost difference would be much higher"

Questions regarding the cost of pesticides:

We bought a 32 ounce spray bottle of synthetic pesticide brand name Sevin at Hardware Hawaii for $8. How much does synthetic pesticide cost for farmers buying in bulk? "$1.25 an ounce and up, some up to $25 an ounce (just an FYI the chemicals found in Sevin are not allowed by the USDA to be on basil)"

How often do they spray the vegetables? "2 times a week"

How much of this pesticide do they use per acre? "Depends on the label instructions, for us mainly 16-64 oz"

How much does organic pesticide cost for farmers buying in bulk? "$1.25 to $25.00 an ounce"

Which brand do you buy? "Dipel DF, Pyganic 1.4, Ecotec"

Where do you buy it? "CPS (Crop Protection Services) or BEI"

How often do you spray the vegetables? "2 times a week"

How much of this pesticide do you use per acre? "Depends on the label instructions mainly 16-64 oz"

We made our own organic pesticide following Mr. Zuckerman's general directions of mixing Hawaiian chili peppers, garlic, and neem oil in a blender and spraying it on the basil once a week. Do you make your own organic pesticide? What is the recipe? "No Sorry"

What is the cost for about 16 ounces?

Do you think making your own organic pesticide is less expensive than purchasing it from a store?

Does the labor involved of cutting up the ingredients make it more cost effective to just buy it from a store?
Are there other production costs we should compare between organic and non-organic growing? "What we have found the hardest is that not all organic pesticides/fungicides are available in Hawaii. We have to constantly wait weeks (6-12) to get the chemicals we need. Which means sometimes we must buy other organic chemicals that don't work as well, which ends up wasting money. Also organic chemicals in Hawaii are not available in bulk (not sure about the mainland). A conventional farmer can buy huge tanks of conventional chemicals, 300 gallons at a time, while we must buy quarts, gallons and, 2.5 gallon size. With all that plastic the cost is higher then."
Do the benefits of organic justify the production costs? "In my opinion yes, with herbs it does"

Questions regarding neem oil:
How common is neem oil used in organic pesticide? "For us, very common"
Do you think neem oil is an effective pesticide? "Yes it is"
Do you know of any negative side effects of neem oil? "Negative, Kind of. The entire leaf of the plant must be sprayed including underneath to get its full benefit"

Questions regarding insects:
Do organic pesticides work as well as synthetic pesticides to keep the bugs off? "Yes, but you must spray more often"
What types of insects are you trying to keep off the basil? "Leps (baby caterpillar types), aphids, mealy bugs, and the worse is the Japanese Rose Beetle"
On our control basil that did not have any pesticide on it, we observed numerous small yellow/brown insects with wings on the basil leaves. A lot of those leaves had round holes in them. Do you know what type of insect this is? "If they were are hard bug, say if you squished them they went and crackle they may be a rose beetle"

Questions regarding community problem:
Are you afraid that neighboring pesticides will blow or wash on top your basil, other vegetables, animals and people/workers? "Yes we are"
How can you tell this is happening? "You can't see it happen, maybe you can smell it, we do random testing on our crops to ensure organic standards, again another cost to incur."
Is there more information we should know about basil and organic pesticide? "Another cost to add for an organic farmer is them getting their organic certificate, technically to use the word organic the farm is to be certified by WSDA, Oregon Tilth, HOFA, etc. One other thing we found out is that by farming organically our soil requires less amendments (cost savings)"
May we present the results of our experiment to you around March? "Yes please"

Thank you very much for your assistance in our science fair project.

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Ms. Kellie Gutheil-Lee, Farm Coordinator, Herbco International, Waianae, Hawaii

Mr. Christian Zuckerman, farmer, Kahumana Farms (non-pBOOKSrofit organic farm) Waianae, Hawaii

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SUBJECT MATTER EXPERTS

Howard Lee, Garden Department of Hardware Hawaii in Kailua, Hawaii

Barry Kim, Supervisor, Koolau Farms, in Kailua, Hawaii

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Basil Height Growth (Inches)

Name Of Plant	11/28/2015	12/13/2015	1/5/2016	1/24/2016		**Total Growth**	Total Growth
Organic Petunia	9"	12"	19 1/2"	26"		**17"**	Average
Organic Chewy	8"	11"	18"	22"		**14"**	
Organic Emma Jr.	12"	15"	18 1/2"	22"		**10"**	
							13.6"
Synthetic Joe	9"	12"	18 1/2"	22"		**13"**	
Synthetic Ella Jr.	7 1/2"	10"	19 1/2"	23"		**15 1/2"**	
Synthetic Ella Jr. II	10"	12"	16"	21"		**11"**	
							13.1"
Control Bob	8"	10"	18 1/2"	25 1/2"		**17 1/2"**	
Control Mo	10"	12"	17 1/2"	23 1/2"		**13 1/2"**	
Control Penny Lu	10 1/2"	12"	15 1/2"	22"		**11 1/2"**	14.1"

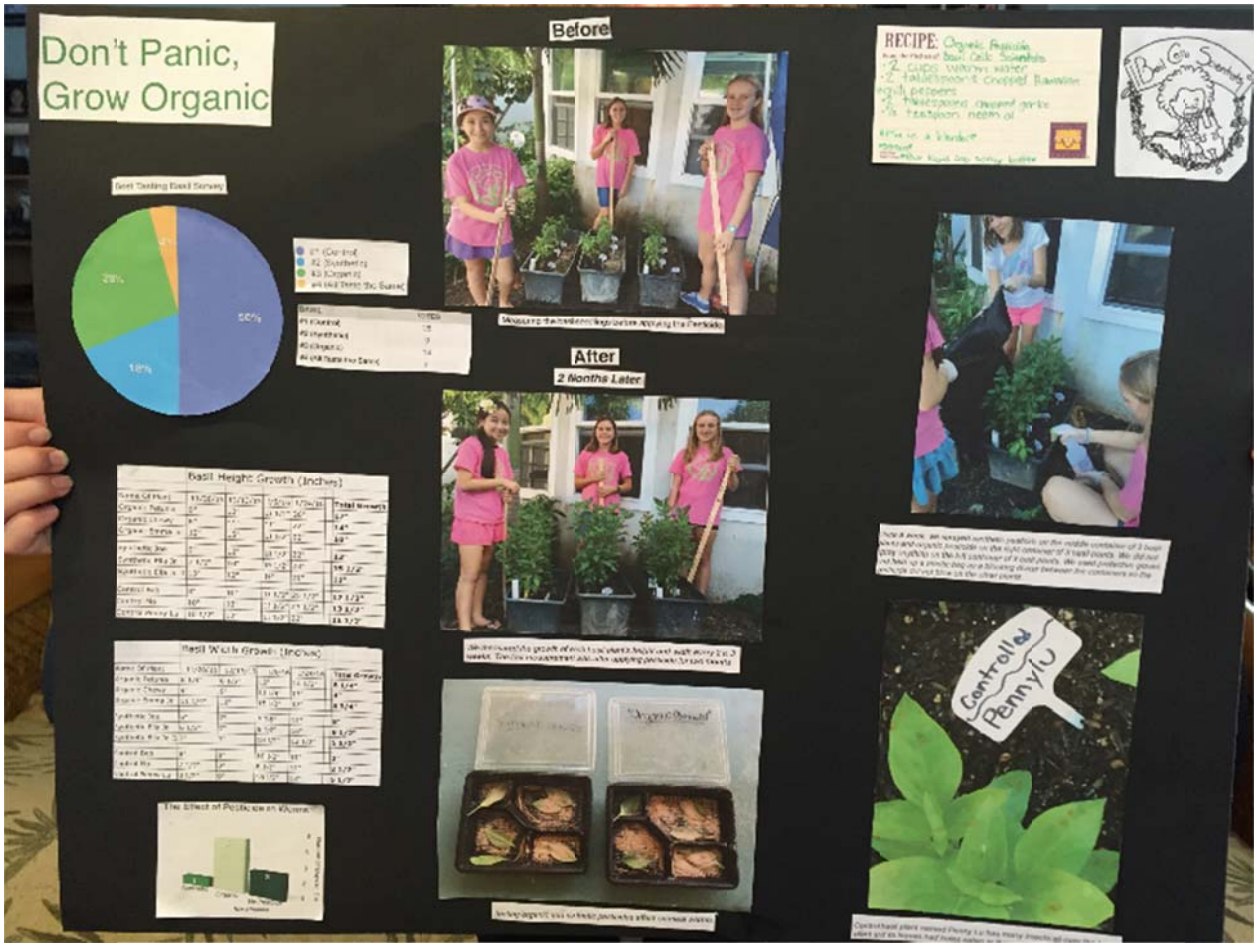
Basil Width Growth (Inches)

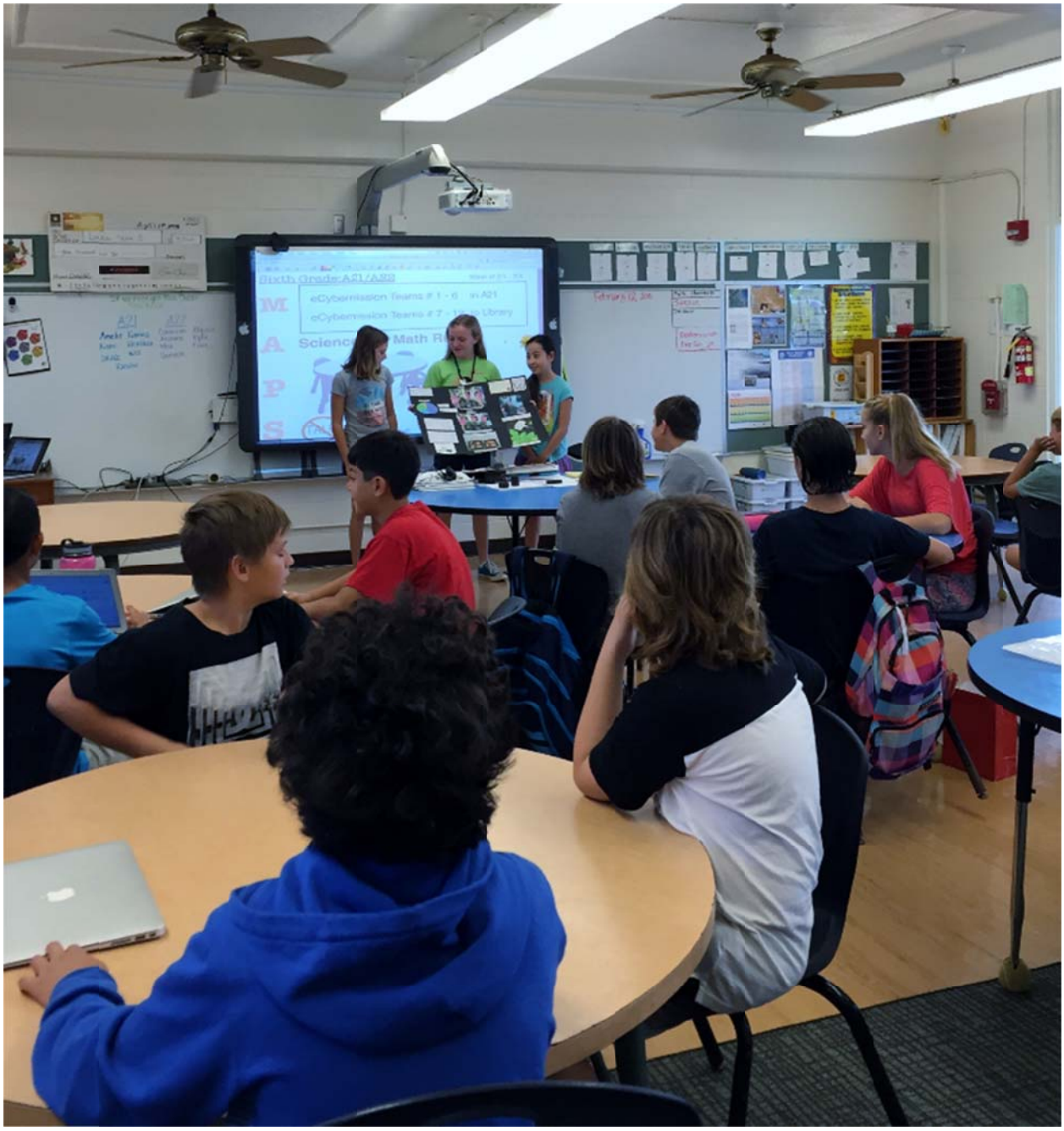
Name Of Plant	11/28/2015	12/13/2015	1/5/2016	1/24/2016		**Total Growth**	Total Growth
Organic Petunia	6 1/4"	6 1/2"	12"	14 1/2"		**8 1/4"**	Average
Organic Chewy	9"	9"	11 1/4"	13"		**4"**	
Organic Emma Jr.	11 1/4"	12"	15 1/2"	17"		**5 3/4"**	
							6"
Synthetic Joe	6"	7"	7 7/8"	11"		**5"**	
Synthetic Ella Jr.	6 1/2"	7"	6 1/2"	16"		**9 1/2"**	
Synthetic Ella Jr. II	7"	7"	10 1/2"	12 1/2"		**5 1/2"**	
							6.6"
Control Bob	8"	8"	10 1/2"	10"		**2"**	
Control Mo	7 1/2"	8"	8 1/2"	11"		**2 1/2"**	
Control Penny Lu	8 1/2"	9"	10 1/2"	13"		**5 1/2"**	3.3"

	COST OF PESTICIDES PER OUNCE	
		COST PER OUNCE
	ORGANIC PESTICIDE	
	Homemade -- our organic pesticide with neem oil	$0.10
	Retail store -- Bayer Advance Natria with neem oil	$0.42
	Retail store -- Bayer Advance Natria concentrate w/neem oil	$0.84
	Retail store -- Farmers buy in small bulk	$1.25 to $25
	SYNTHETIC PESTICIDE	
	Retail store -- Sevin	$0.25
	Retail store -- Farmers buy in large bulk	$1.25 to $25

PRICE OF BASIL

		Herbco Thai Basil	Herbco Thai Basil		Local	Local
	RETAIL GROCERY STORE	**ORGANIC**	**ORGANIC**		**NON-ORGANIC**	**NON-ORGANIC**
		Wholesale	**Retail**		**Wholesale**	**Retail**
		1 ounce	1 ounce		1 ounce	1 ounce
	Safeway	$1.67	$3.99		$0.37	$1.50
	Wholefoods	$1.67	$3.99		--	--
	Foodland	$1.67	$5.32		$0.37	$0.95
	Times Supermarket	$1.67	$3.19		--	--


Don't Panic, Grow Organic
Before
After
2 Months Later
RECIPE:
Basil Height Growth (Inches)
Basil Width Grown (Inches)
Control
Penny U


Sixth Grade: A21/A22
eCybermission Teams # 1 - 6 in A21


Don't Panic
Grow Organic


ORGANIC
PESTICIDE
Basil Cello Scientists

QUESTIONS FOR FARMERS THAT USE NON-ORGANIC PESTICIDE

Farmer Name: _____

Farm's name and address: _____

Date: _____ **Student Name: _____**

1. What type of insects are you trying to keep off the basil? _____

_____

At what point in growing basil do you start spraying the pesticides? _____

_____

How often do you apply pesticide? _____

How do you apply the pesticide? _____

2. What brand of pesticide do you use on basil? Where do you buy it from? _____

_____

3. Do you sell more or less basil than farmers that use organic pesticide? _____

Which stores do you sell to? _____

How much higher is the cost of organic basil than non-organic basil? _____

_____

4. Have you ever considered using organic pesticides? _____

Does regular pesticide works better than organic pesticide?_____

_____

5. Do you have other concerns about basil and pesticide? _____

_____

6. Is there more information we should know about basil and pesticide?

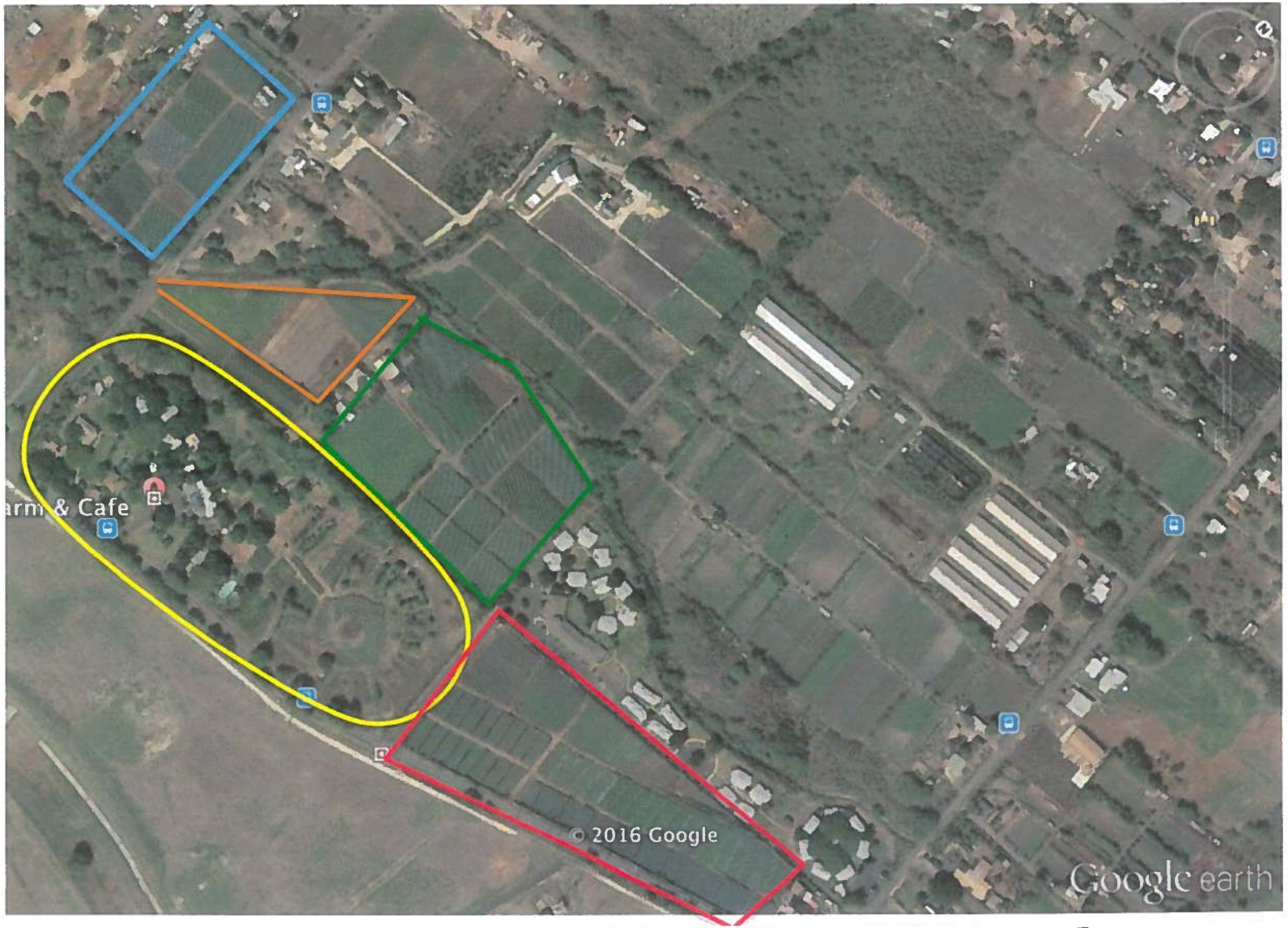
_____

_____

_____

7. May we present the results of our experiment to you around January? _____

Thank you very much for your time and cooperation with this interview for our science project.



Key:
yellow= Kahumana Organic Farm
Red= Nonorganic Farm
Blue= nonorganic Farm
Green= nonorganic Farm
Orange= nonorganic Farm

eCYBERMISSION Survey Approval Form

eCYBERMISSION team name: Lanikai Team #1 Basil Cello Scientists

Team Advisor name: Mr. Parker Sawyer

Team Advisor email: psawyer@lanikaischool.com

Team Advisor phone:

Student usernames: basilcello2, Memma808, mrplurp

School name: Lanikai Elementary

School address: 140 Alala Road, Kailua HI 96734

Describe the survey your team will conduct:

Our team will conduct a taste test of the basil we grew to see which category of basil the subjects think taste the best. Our three categories of basil we will offer them to taste came from being sprayed with organic pesticide, synthetic pesticide, and no pesticide. We will wash the basil leaves and our hands carefully beforehand.

Describe the participants you plan to distribute your survey to:

Our family members, friends, teachers, and fellow students.

Project approved by school administration?

☑ Yes ☐ No

Approved by: Ed Noh

Title: Principal

Date approved: 1/19/16

Signature, School Administrator:

Ed Noh

*Please save form and upload to your team's Mission Folder.

Neem's Low Relative Toxicity

One of the main differences between neem and other pesticides – even natural pesticides like pyrethrum and nicotine – is its extremely low toxicity. Although there are reports of people being seriously injured when neem oil is taken internally, it's extremely rare even in countries where neem is often used much like our grandmothers used castor oil.

Scientists measure toxicity with a test called LD50 – or Lethal Dose, 50% -- which calculates how much of a substance it takes to kill half of the animals, insects or microbes tested. It is a relative indicator of the substance's acute toxicity. Here is how neem stacks up against some other insecticides. This indicates its relatively low risk for any humans and other mammals.

	LD50 (mg/kg)	Oz per 150 lb person
Nicotine Sulfate	50–55	0.1
Sevin	246–283	0.6
Aspirin	1200	2.8
Rotenone/Pyrethrum	1500	3.6
Malathion	2800	6.7
Table Salt	3320	8.0
Neem	7500	18.0

Courtesy Kerr Center for Sustainable Agriculture

Haas, Sheila NEEM: A HANDS ON GUIDE TO ONE OF THE WORLD'S MOST VERSATILE HERBS

TABLE 14

Photo 8: 5/21/16: Interview Mr. Christian Zuckerman, farmer at Kahumana Organic Farm

Photo 9: 8/6/16: Interview Mr. Bill Durston, owner of Leilani Nursery, and his assistant Pua.

Photo 10: 9/3/16: We interviewed Dr. Uromi Goodale at the IUCN World Conservation Congress in Honolulu. She is a botanist with a PhD. in Plant Ecophysiology from Yale University and teaches at a university in China. We are wearing our Lanikai Science Squad team shirts with our logo designed by Heather and Jasmine.

Photo 11: 10/15/16: We interviewed Dr. Saleem Ahmed at the Aloha Aina Nursery in Honolulu. He is an expert on neem and contributed to the book “Neem, A Tree For Solving Global Problems”. In this photo are neem plants in the black pots and they are about 1 year old.

Photo 12: 10/16/16: A newly re-planted neem tree from from Dr. Ahmed's nursery to Lanikai park, which is in our neighborhood.

Photo 13: 8/6/16: Making homemade organic pest control solution with water, garlic, Hawaiian chili peppers, and neem oil.

Photo 14: 8/6/16: Applying pesticides to our cilantro plants using safety precautions -- face masks and gloves. We held up trash bags so the specific type of pesticide we were applying could not drift to the other plants.

Photo 15: 8/6/16: We planted 9 organic cilantro seedlings in organic soil with organic fertilizer in 3 separate orange garden boxes to be the control, synthetic pesticide, and organic pest control. We did the same procedure in planting 9 organic kale seedlings in 3 separate green garden boxes.

Photo 16: 8/15/16: Testing organic and synthetic pesticides effect on meal worms.

Photo 17: 8/15/16: Testing organic and synthetic pesticides effect on crickets.

Photo 18: 8/26/16: Within 3 weeks, 7 of the 9 cilantro plants had died. We planted 9 organic rosemary seedlings in organic soil with organic fertilizer in 3 separate orange garden boxes to be the control, synthetic pesticide, and organic pest control.

Photo 1: 8/21/16: Cilantro sprayed with synthetic pesticide has a white coating on its leaves.

Photo 2: 8/21/16: Cilantro control had no pesticide applied and has 3 black bugs on leaves.

Photo 3: 9/4/16: Kale sprayed with synthetic pesticide has many holes in its leaves. The round shape of the holes is from slugs and snails which come out at night. You can see brown slug on the leaf.

Photo 4: 9/17/16: After 6 weeks of applying synthetic pesticide to the kale in the middle garden box and organic pest control to the box on the right and no pesticide to the control box on the left, the healthiest looking kale is in the organic box on the right.

Photo 5: 10/9/16: After 6 weeks of applying synthetic pesticide to the rosemary in the middle garden box and organic pest control to the box on the right and no pesticide to the control box on the left, all the rosemary grew healthy except synthetic Rose whose leaves were extremely light green because of the pesticide.

Photo 6: 11/8/16: Using a microscope, observed the bug from the control cilantro plant.

Photo 7: 11/8/16: Using a magnifying glass, observed a rosemary leaf That has white dots from the chemicals in the synthetic pesticide.

Table 1. KALE HEIGHT GROWTH (INCHES)							
Name of Plant	Week 1 Day 1	Week 3 Day 1	Week 5 Day 1	Week 6 Day 7		Total Growth (in)	Total Average Growth
Control Lily Bean	9 1/2	12 1/4	16 1/2	16		6 1/2"	
Control Harry	11	15	17	17 1/2		6 1/2"	
Control Kekipi	11 1/4	12	15	15 1/2		4 1/4"	
							5 3/4"
Synthetic Fluffy	10 3/4	13 1/2	16	14		3 1/4"	
Synthetic Heather Jr.	9 3/4	11	16	15		5 1/4"	
Synthetic Ella Jr.	10 1/2	11	15	dead		4 1/2"	
							4 3/10"
Organic Pikalechu	12	12 1/2	13	16		4"	
Organic Kachina	10 1/2	16	14	16 1/2		6"	
Organic Emma Jr.	9	9	11 1/2	15		6"	5 3/10"

Table 2. KALE WIDTH GROWTH (INCHES)

Name of Plant	Week 1 Day 1	Week 3 Day 1	Week 5 Day 1	Week 6 Day 7	Total Growth (in)	Total Average Growth
Control Lily Bean	9 1/2	18	18	23	13 1/2"	
Control Harry	12 1/4	20	20	29	16 3/4"	
Control Kekipi	10 1/4	23	25	25	14 3/4"	
						15"
Synthetic Fluffy	8 1/4	19	20	20	11 3/4"	
Synthetic Heather Jr.	7 1/2	21	19	17	9 1/2"	
Synthetic Ella Jr.	8	14	17	dead	9"	
						10 2/25"
Organic Pikalechu	12	16	21	20	8"	
Organic Kachina	10 1/4	23	19	19	8 3/4"	
Organic Emma Jr.	10	15	17	18	8	8 1/4"

Table 3. KALE #BUGS/#HOLES IN LEAVES				
	Week 1 Day 1	Week 3 Day 1	Week 5 Day 1	Week 6 Day 7
Control Lily Bean	0/0	0/9	0/14	0/13
Control Harry	0/0	0/18	0/10	0/10
Control Kekipi	0/0	0/12	0/30+	0/0 (Dying, leaves with holes fell off)
Synthetic Fluffy	0/0	0/2	1/30+	0/30+
Synthetic Heather Jr.	0/0	0/1	0/17	0/30+
Synthetic Ella Jr.	0/0	0/0	0/0	Dead
Organic Pikalechu	0/0	0/6	0/0	0/12
Organic Kachina	0/0	0/0	0/0	0/27
Organic Emma Jr.	0/0	0/0	0/3	0/21

Table 4. ROSEMARY HEIGHT GROWTH (INCHES)							
Name of Plant	Week 1 Day 1	Week 3 Day 1	Week 5 Day 1	Week 6 Day 7		Total Growth (in)	Total Average Growth
Control Missy Blume	10	8	8	9		-1"	
Control Rainy	7 1/2	7 1/2	7 1/2	7 1/2		0"	
Control Succulant Joe	5	5 1/2	5 1/2	6		1"	
							0"
Synthetic Delta 2.0	9	10	10	11		2"	
Synthetic Evee	10	10 1/2	10 1/2	6 1/2		-3 1/2"	
Synthetic Rose	8	8	8	8 1/4		1/4"	
							-2/5"
Organic Rosemary Jr.	9 1/2	9 1/2	9 1/2	7 1/2		-1 1/2"	
Organic Taco	6 1/2	6 1/2	7	9		2 1/2"	
Organic Mary	6 1/2	7 1/2	7	9 1/4		2 3/4"	1 1/2"

Table 5. ROSEMARY WIDTH GROWTH (INCHES)							
Name of Plant	Week 1 Day 1	Week 3 Day 1	Week 5 Day 1	Week 6 Day 7		Total Growth (in)	Total Average Growth
Control Missy Blume	6	6 1/2	7	6		0"	
Control Rainy	5	6 1/2	6 1/2	7		2"	
Control Succulant Joe	5	5 1/2	6	7 1/2		2 1/2"	
							1 1/2"
Synthetic Delta 2.0	5	6 1/2	6 1/2	8		3"	
Synthetic Evee	5	8 1/2	8 1/2	10		5"	
Synthetic Rose	5	7	7	11 1/2		6 1/2"	
							4 4/5"
Organic Rosemary Jr.	7	5 1/2	6 1/2	8		1"	
Organic Taco	6 1/2	6	6	7		1/2"	
Organic Mary	4	4	5	7 1/4		3 1/4"	1 3/5"

Table 6. ROSEMARY #BUGS/#HOLES IN LEAVES				
Name of Plant	Week 1 Day 1	Week 3 Day 1	Week 5 Day 1	Week 6 Day 7
Control Missy Blume	0/0	2/0	0/0	3/0
Control Rainy	0/0	1/0	3/0	4/0
Control Succulant Joe	0/0	5/0	7/0	3/0
Synthetic Delta 2.0	0/0	0/0	0/0	0/0
Synthetic Evee	0/0	0/0	0/0	0/0
Synthetic Rose	0/0	0/0	0/0	1/0
Organic Rosemary Jr.	0/0	0/0	0/0	0/0
Organic Taco	0/0	0/0	0/0	1/0
Organic Mary	0/0	0/0	0/0	0/0

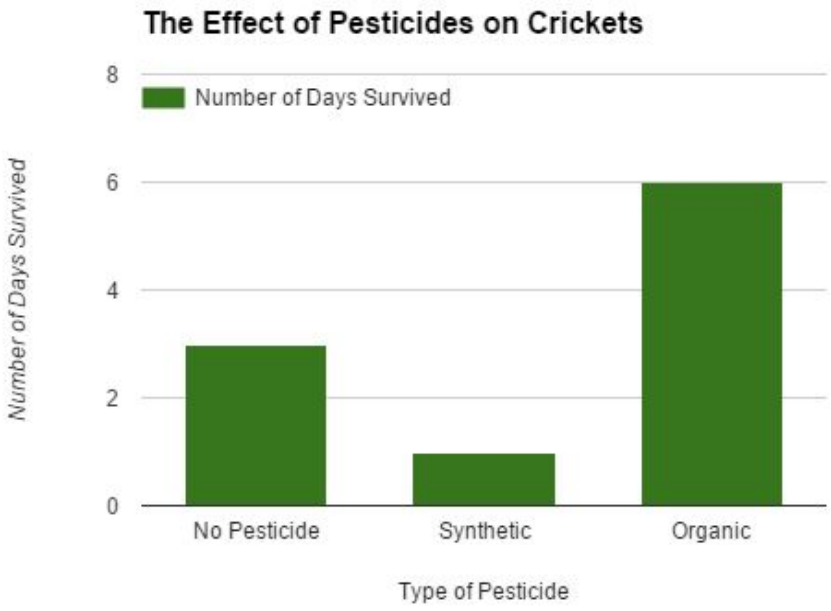
Table 7. CILANTRO GROWTH HEIGHT (INCHES)						
Name of Plant	Week 1 Day 1	Week 3 Day 1	Week 4 Day 1		Total Growth (in)	Total Average Growth
Control Jasmine Jr	3	5	5		2"	
Control Kaipo	3 1/2	7 1/2	6 1/2		3"	
Control 'Auli'i	3	Dead	Dead		0"	
						1 7/10"
Synthetic Bob	3 1/2	5 1/2	5 1/2		2"	
Synthetic Molly Lu	3	Dead	Dead		0"	
Synthetic Skywalker	3 1/2	6 1/2	6 1/2		3"	
						1 7/10"
Organic Delta	4	7 1/2	Dead		3 1/2"	
Organic Percy	3 1/2	Dead	Dead		0	
Organic Braelyn	2 1/2	4 3/4	Dead		2 1/4"	1 9/10"

Table 8. CILANTRO WIDTH GROWTH (INCHES)						
Name of Plant	Week 1 Day 1	Week 3 Day 1	Week 4 Day 1		Total Growth (in)	Total Average Growth
Control Jasmine Jr	4 1/2	8	8		3 1/2"	
Control Kaipo	4	7	8 1/2		4 1/2"	
Control 'Auli'i	3 1/2	Dead	Dead		0"	
						2 7/10"
Synthetic Bob	4 1/2	6	7		2 1/2"	
Synthetic Molly Lu	3 3/4	Dead	Dead		0"	
Synthetic Skywalker	3 3/4	7	7 1/2		3 3/4"	
						2 2/25"
Organic Delta	4 1/2	10	Dead		5 1/2"	
Organic Percy	4 1/2	Dead	Dead		0"	
Organic Braelyn	4 1/2	7 1/2	Dead		3"	2 4/5"

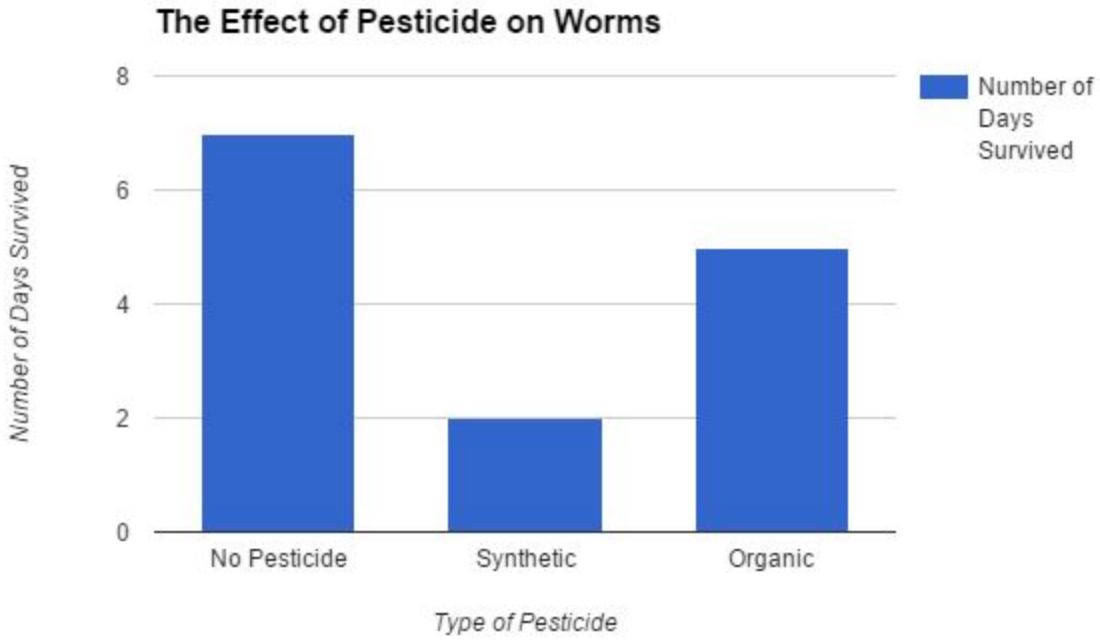
Table 9. CILANTRO #BUGS/#HOLES IN LEAVES			
Name of Plant	Week 1 Day 1	Week 3 Day 1	Week 4 Day 1
Control Jasmine Jr	0/0	6/0	0/0
Control Kaipo	0/0	10/0	0/0
Control 'Auli'i	0/0	Dead	Dead
Synthetic Bob	0/0	0/0	0/0
Synthetic Molly Lu	0/0	Dead	Dead
Synthetic Skywalker	0/0	0/0	0/0
Organic Delta	0/0	0/0	Dead
Organic Percy	0/0	Dead	Dead
Organic Braelyn	0/0	0/0	Dead

Table 10. KALE MOISTURE METER				
Name of Plant	Week 1 Day 1	Week 3 Day 1	Week 5 Day 1	Week 6 Day 7
Control Lily Bean	-	3 1/2	4 1/4	4 1/4
Control Harry	-	3 1/2	4 1/2	4 1/2
Control Kekipi	-	3 1/2	4 1/2	4 1/2
Synthetic Fluffy	-	4 1/2	3 1/2	4 1/2
Synthetic Heather Jr.	-	4	4 1/4	3 1/4
Synthetic Ella Jr.	-	4	3 1/2	4 3/4
Organic Pikalechu	-	4 1/4	4 3/4	4 3/4
Organic Kachina	-	4 1/4	4 1/2	5
Organic Emma Jr.	-	4 1/4	4 1/2	5

Table 11. ROSEMARY MOISTURE METER				
Name of Plant	Week 1 Day 1	Week 3 Day 1	Week 5 Day 1	Week 6 Day 7
Control Missy Blume	-	1	1 1/2	4
Control Rainy	-	3	1 1/4	3
Control Succulant Joe	-	4 3/4	1 1/2	4
Synthetic Delta 2.0	-	1	3	3
Synthetic Evee	-	4	4	4
Synthetic Rose	-	4	4 1/2	2
Organic Rosemary Jr.	-	4 3/4	4 1/4	4
Organic Taco	-	4 3/4	4 1/2	4
Organic Mary	-	4 3/4	4 1/2	4



Graph 2



Graph 1

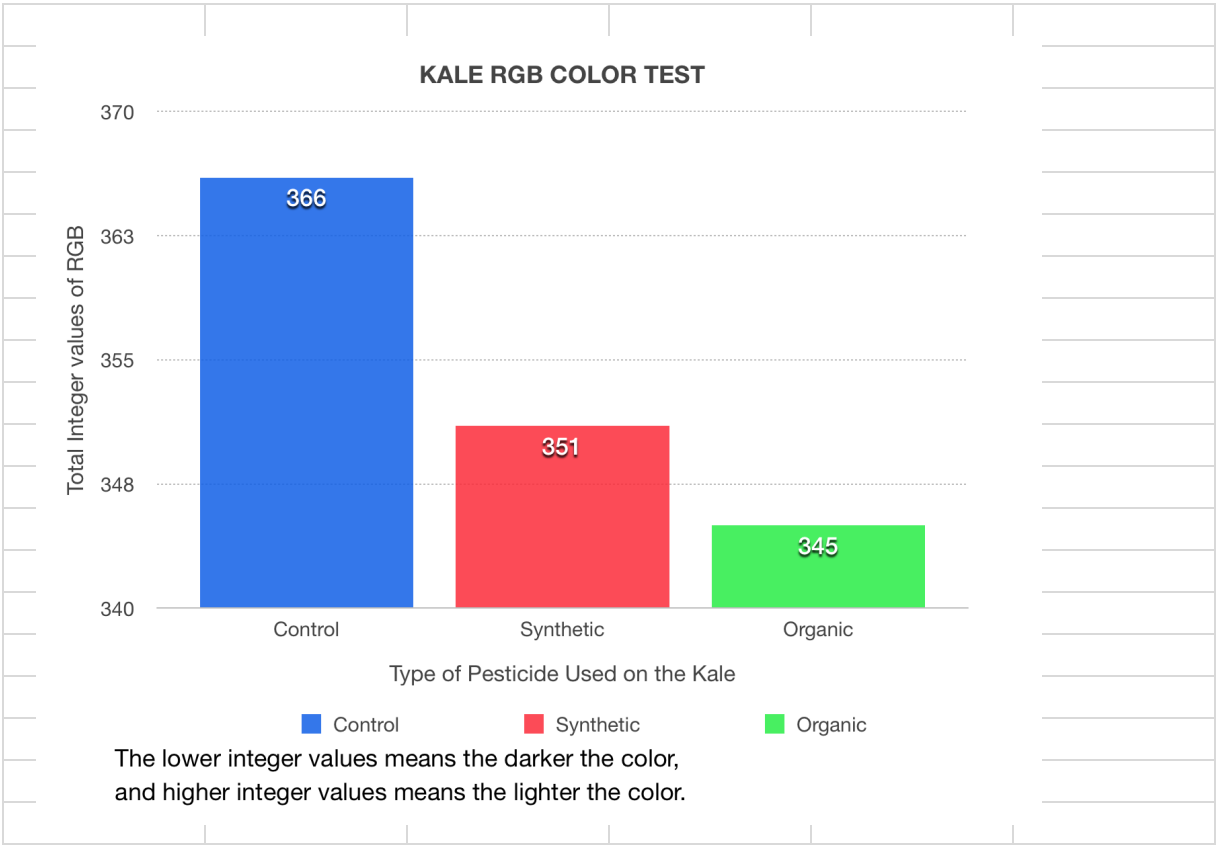
KALE RGB COLOR TEST (Table 12)			
RGB	**Control**	**Synthetic**	**Organic**
Red	123	118	117
Green	146	140	137
Blue	97	93	91
Total	366	351	345

The lower integer values means the darker the color,
and higher integer values means the lighter the color.

ROSMARY RGB COLOR TEST (Table 13)

RGB	Control	Synthetic	Organic
Red	84	79	88
Green	132	124	132
Blue	91	87	95
Total	307	290	315

The lower integer values means the darker the color,
and higher integer values means the lighter the color.


KALE RGB COLOR TEST
370
363
355
348
340
Total Integer values of RGB
366
351
345
Control
Synthetic
Organic
Type of Pesticide Used on the Kale
Control
Synthetic
Organic
The lower integer values means the darker the color,
and higher integer values means the lighter the color.

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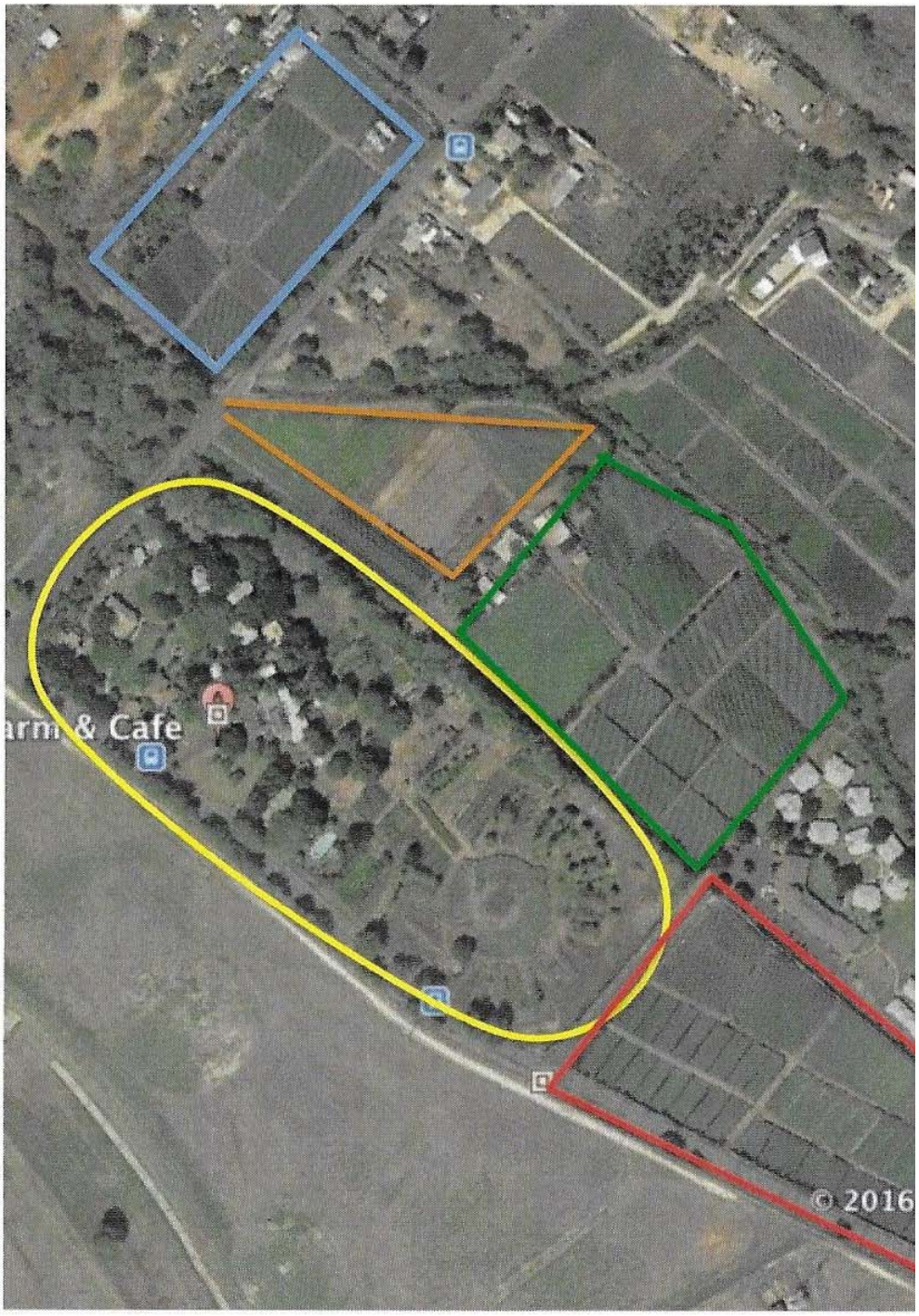

Key: yellow = Kahumana Organic Farm

Table 15. COST OF PESTICIDES PER OUNCE	
	COST PER OUNCE
ORGANIC PESTICIDE	
Homemade -- our organic pest control with neem oil in spray bottle	$0.13
Retail store -- Bayer Advance Natria with neem oil	$0.42
Retail store -- Bayer Advance Natria concentrate w/neem oil	$0.84
Retail store -- Bonide neem oil insecticide	$0.31
Retail store -- Bayer Natria insecticide soap	$0.29
Retail store -- Farmers buy in small bulk	$1.25 to $25
SYNTHETIC PESTICIDE	
Retail store -- Sevin	$0.25
Retail store -- Farmers buy in large bulk commercial line	$.16 to $3.12

Table 16. PRICE OF KALE

		ORGANIC Wholesale 1 ounce	ORGANIC Retail 1 ounce		NON-ORGANIC Wholesale 1 ounce	NON-ORGANIC Retail 1 ounce
	RETAIL GROCERY					
	Safeway	$0.15	$0.32		$0.09	$0.16
	Wholefoods	--	$0.40		--	--
	Foodland	--	$0.22		--	$0.16
	Times Supermarket	--	--		$0.08	$0.12
	Target	--	$0.79		--	$0.60

Table 17. PRICE OF ROSEMARY

		ORGANIC	**ORGANIC**		**NON-ORGANIC**	**NON-ORGANIC**
		Wholesale	**Retail**		**Wholesale**	**Retail**
		1 ounce	1 ounce		1 ounce	1 ounce
	RETAIL GROCERY					
	Safeway	--	--		$2.50	$3.99
	Wholefoods	$1.80	$3.98		--	--
	Foodland	$1.80	$3.32		--	$1.37
	Times Supermarket	$1.80	$3.19		--	--
	Target	--	--		--	$3.98

Table 18. PRICE OF CILANTRO

		ORGANIC	ORGANIC		NON-ORGANIC	NON-ORGANIC
		Wholesale	Retail		Wholesale	Retail
		1 ounce	1 ounce		1 ounce	1 ounce
	RETAIL GROCERY					
	Safeway	$0.38	$0.62		$0.30	$0.62
	Wholefoods	--	$0.62		--	--
	Foodland	--	--		--	$0.99
	Times Supermarket	--	--		$0.23	$0.50
	Target	--	--		--	$3.98

Photo 19: 5/21/16: Our 6th grade ECM team gave a presentation and distributed our homemade organic pest control at the Kahumana Farm Festival in Waianae, Hawaii.

Photo 20: 5/13/16: Our 6th grade Ecybermission team's slide show presentation on our research on organic pesticide at the Pacific American Foundation Student Science Conference at the NOAA Inouye Regional Center in Honolulu.

Photo 21: 1/16/17: Our 7th grade ECM team's presentation poster board, booklet to farmers, and sample bottle of our homemade pest control.

Photo 22: 1/19/17: Our 7th grade ECM team presented our research and data on organic pest control to Lanikai Elementary School.

Photo 23: 2/14/17: Our 7th grade ECM team presented our research and data on organic pest control to Kailua Intermediate School.

Photo 24: 2/16/17: Emma presented our research at Punahou School.