Abstract

eCYBERMISSION Team Name	Ants Go Marchin' 2 by 2
Team Grade	7th Grade
Project Start Date	April 1, 2014
Project Finish Date	Project is ongoing but was submitted for judging March 4, 2014

Describe your project and explain how you used STEM (Science, Technology, Engineering and Mathematics) to improve your community (250 words or less)

The health of our soil is a major issue in the state and across the Midwest. The overuse of chemicals means the living parts of soil are in serious decline. Many farming practices have worked against themselves by taking living soil and turning it into nothing more than dead dirt. Our team's goal was to improve soil health.

Research & experiments were conducted with scientists from Texas Tech and the NRCS (soil conservationists). The team formed several hypotheses/tests and found solutions.

- Fungal levels– soil was analyzed; found deficient in beneficial fungi
- Mycorrhizae Fungi – benefited plant roots & soil when added to seed
- Humic Acid – Improved seed germination in native and crop seed tests
- Harvester Ants – used ants to inoculate soil with fungi by designing a seed coating to attract them
- Ants see in UV – Coated seeds with fungal spores & pyranine that fluoresces in UV; seeds were selected 50% more often over uncoated seeds by ants

Solutions/Benefits:

- Humic acid boosted soil productivity
- Mycorrhizae fungi restored to local soils
- Harvester ants effectively spread fungi during grassland restoration
- UV coated seed pellets attracted ants and encouraged the spread of fungus underground
- Ranchers & gardeners benefited
- Water conservation resulted from improved soil

Careless stewardship of our nation's soil will lead to collapse for agricultural communities and disaster for all who rely on them. Our team used STEM to improve soil health and positively impact our community for the future.

Tips for writing your abstract:
- Do not go into too much detail about one certain area - be brief!
- Include a problem statement and/or your hypothesis
- Summarize procedures and the important steps you took to solve your problem
- Briefly discuss your observations and results
- Summarize conclusions and/or next steps
- Do not go over 250 words!

*Please e-mail completed abstracts to swhitsett@ecybermission.com or fax to 703-243-7177 by April 15.

State	Texas
Grade	7th
Mission Challenge	Environment
Method	Scientific Inquiry using Scientific Practices
Students	Happyhs (Submitted on: 3/4/2014 2:19:48 PM) Happydr (Submitted on: 3/4/2014 2:18:35 PM) Happyds (Submitted on: 3/4/2014 2:19:04 PM) Happyhf (Submitted on: 3/4/2014 2:19:24 PM)

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.

Please see attachments – Team Responsibility Chart, Timeline and Team Plan

It was a year of superlatives for Texas. It was the worst single year drought in 75 years, the longest run of 100+ temperatures in decades, and the largest agricultural loss in the state's history. A dust storm arose in our town, growing so severe that darkness was seen mid-day as huge clouds of red dirt covered the region. The event would make the NBC Nightly News, causing many to wonder if the Dust Bowl days were returning to this nation.

In an area dominated by agriculture, the health of our soil is a major issue in the state and across the mid-west. "Ants Go Marchin' 2 by 2" is a team of seventh graders from our after school STEM enrichment program. We identified the decline of soil health as a community problem. Our process that would ensure that jobs were done correctly and deadlines were met began by choosing the right members for this project. Two team members participated in Ecybermission as sixth graders so we looked for additional members interested in protecting the environment and improving the health of soil. We also looked for students who could follow a schedule, complete assignments on time, and be organized. The use of email, instant messages, Google Drive, and text reminders kept everyone on the track. It was important to come to the meetings, to be friendly, and to listen to each other's ideas. We wanted creative and respectful students on the team. A long-term project would mean many months of work. Students needed to be dedicated to the task and people who did not give up easily. Our team came together in May 2013 and we were a group who was able to see beyond a Mission Folder and realize the bigger picture of improving the agricultural soils of this community.

We met from 4:00-6:00 on Monday and Tuesday each week, balancing STEM with basketball, track, and one-act-play schedules from the three schools we attend. We spent several weekends focused on this project. We kept a 3-ring binder with hard copies of our assignment book and objectives listed. The school computer networkhad a place for all the electronic files for our team, including an assignment sheet, timeline, goals, experiments, dates, and next steps.

All members were involved in brainstorming a specific idea to improve soil, thinking of possible experts who could help, finding solutions that were testable and realistic, and supporting one another. It took all of us working together to complete the assignments. We supported the goals of the team and compromised when necessary. We learned to listen to other opinions, and respect the ideas and talents of each member. We each brought unique talents to the team and we were a group of individualists, marching to the beat of a different drum, so to speak. George is excellent in the areas of public speaking, organization, and writing, as well as having the ability to speak three languages. Since our community has a large Hispanic population and German Mennonite population, it was useful to have a team member who could communicate well with all three populations. He also kept track of the assignment book and made sure deadlines were met. Hudson is talented in research and interpretation, as well as having a sharp memory for details. During public presentations, he took the lead during open question and answer sessions. His experience with one act play made him very good with the media as well. Hudson was the webmaster for the team and kept the website updated as new discoveries were made. Davis is a creative thinker who can see many sides of an idea and play devil's advocate with the team. This was helpful in troubleshooting problems before they even arose. His skills in statistics helped the format data tables and graphs, analyze the information, and determine whether the results were significant. His knowledge of farming and the outdoors was very helpful to the team and with his father being a wildlife refuge manager, he had many connections to subject matter experts. Christina is highly efficient, takes charge of accomplishing tasks within the time limit of meetings, and records qualitative data for the team. If there is ever a question about any lab work that was done, she finds the answer because it is written down and saved online and in our binder. She is also the team photographer and was an expert in the use of refractometers because of prior use with the instrument during a science fair project. She is on the school writing team and was a primary writer of the lab reports.

All students shared the responsibility for completing the Mission Folder and individual tasks were chosen based on strengths of the individual. An action plan was developed early in the project and all members stayed on track by fulfilling the objectives as planned.

Uploaded Files:

- [**View**] **Team Responsibilities Chart** (By: Happyds, 03/03/2014, .pdf)

  A chart shows how some of the responsibilities were divided among team mates during this project.

- [**View**] **Team Timeline** (By: Happydr, 03/04/2014, .pptx)

  This timeline shows the progress of the team from April 2013 to March 2014.

Scientific Inquiry

Problem Statement

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

Feeding our soil is the first and most important step in feeding ourselves. "The soil layer surrounding Earth is rich, diverse, and a living entity," states soil biologist Dr. Elaine Ingham. Farmers, ranchers, and wildlife depend on soil health. Many farming practices have worked against themselves by taking this symphony of living soil and turning it into nothing more than dead dirt. The overuse of pesticides, herbicides, and fungicides mean that the living parts of soil are in serious decline. Careless stewardship of our nation's soil will lead to collapse for agricultural communities and disaster for all those who rely on them – in essence, the entire population.

Problem Statement – Have the use of chemicals on the county's agricultural land negatively affected the living component of the soil; and, if this is depleted, can the health of the soil be improved?

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

Please see attachment – Bibliography, Contact List

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(3) Describe what you learned in your research.

Evidence of chemical use and a decline in agricultural productivity has encouraged us to seek research-based answers for our community. Research began with each team member searching for credible individuals and institutions in our town that would be the experts we looked to for answers. This would form the foundation of our experiments and lead to a scientific solution for agriculture.

Soil is a life-giving substance, without which all mankind would perish. The world population is growing and food production is in greater demand than ever. A healthy soil will be productive and it is vitally important that this issue be addressed. According to the Natural Resources Conservation Service, “Improving the health of our Nation’s soil is one of the most important endeavors of our time.”

To learn ways we could make a difference, we interviewed professionals in the fields of agriculture and ecology (Dr. Darryl Birkenfeld). We talked with farmers, soil conservationists, Western Farm Press editors, and West Texas Agriplex scientists (Mr. Joe Roberts, Mr. Landon Kerby, Mr. Harry Cline, Mr. Justin Trammell, Russell Martin, Dr. Bill Jones, Mr. Jude Smith). After interviewing those who work the land on a daily basis, we came to some revelations. All agreed that the conventional way of planting, harvesting, and tilling fields could contribute to the problem of declining soil health. A farmer has to make a living and allowing insects to eat the cotton crop is not a solution for 65% of our community who are the land stewards. These experts seemed conflicted. With the loss of healthy topsoil comes dead dirt, poor soil quality, a decrease in the ability of soil to hold water, and a decline in air quality and crop production in the long run. Preventing soil decline early on is always better than reversing the effects later; therefore, we researched conventional ways of restoring life to the soil before brainstorming methods of our own.

Resources included newspaper articles (Lubbock Avalanche -Journal), professional newsletters (Western Farm Press, Southwest Farm Press), reputable websites (government sites, sites with extensive bibliographies, and university sites), Journal of Sustainable Agriculture, and the US Department of Agriculture. From these sources we learned that soil health has a positive impact on conservation and productivity. In order for farmers and ranchers to feed the world more sustainably and with greater profit, attention should be focused on improving soil health.

Research led us to a retired Texas Tech University biochemical engineering professor, Dr. Bill Jones. Now leading the research in soil science at the Sara Spade Research Institute, Dr. Jones met with our team and encouraged us to begin testing the soil from area fields and looking for evidence of fungi – the most important component in living soil, according to this scientist. Further research online introduced us to a foremost authority on mycorrhizal fungi, Dr. Michael Martin Melendrez of New Mexico. The webinars and videos available online were extremely useful in narrowing down one way we could restore soil health to the fields and native grasslands of our county. Our focus would be on mycorrhizae and humic acid – the two critical ingredients in building healthy soil.

Up to this point, our research was focused on ways we could help soil by adding healthy substances to the land. We thought about the times we'd seen ants collect seeds and carry them underground. What if we could get the ants to collect mycorrhizae for us and then the ants (nature itself, really) would help in spreading the fungi and healing the soil? Nature helping nature. By mimicking the way ants work and designing a pellet with the beneficial fungi inside, perhaps these insects could do some of the work for us. Research into ants commonly found in our county, taught us that "harvester ant" is a common name for a genera of ants that collect seeds. Seed harvesting ants increase seed dispersal for the land and provide nutrients that allow more seedlings to survive. In addition, ants provide soil aeration by creating galleries and chambers, mixing deep and upper layers of soil, and incorporating organic waste into the soil. Ants play an important role in plant communities by acting as seed dispersal agents.

Lastly, an article in Smithsonian Magazine reported the findings of scientists in India in which ants were discovered to be attracted to the carnivorous pitcher plant because of a coating on the plant's "mouth" that is fluorescence under ultraviolet light. This gave us the idea of coating a seed pellet with pyranine that might attract an ant more effectively than with an uncoated seed pellet. (Plus, black lights are really awesome)

Hypothesis

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

Hypothesis – If the soil of our county is found to have low amounts of fungi, then soil health is compromised. If the soil can be inoculated with mycorrhizae and humic acid, then the result will be improved soil conditions, provide for increased rates of seed germination, and result in healthier plant life.

There are two ways in which this hypothesis could help solve the problem of the lack of fungi in soil. One way is inoculation by man; the second way is inoculation by nature.

1) If mycorrhizae and humic acid can be applied to seeds before planting and offered to farmers, their crops could be improved and the health of their soil more robust because of the symbiotic relationship between the plant roots and the mycorrhizae fungi. The key will lie in whether or not the fungi + humic coating improves germination and plant growth.

2) If we develop a seed pellet that contains mycorrhizae fungi and is gathered readily by harvester ants, then the insects will inoculate the soil with fungi as they move about with the seed underground. The key will lie in making the pellet highly desirable for the ants.

Each individual experiment that was conducted has its own hypothesis that is recorded below:

Test 1 - Determining Fungal Levels in the Soil of Cochran County

If the cotton field that has been treated with pesticides and herbicides is tested for the presence of fungi, then low levels will be found due to the ongoing effects of chemical residue. If the farmed playa wetland is without a grassland buffer, then low levels of fungi will be found in that soil due to chemical run-off that occurred. If sand is tested for fungi, then its dryness and sterility will result in a small amount of fungi. If rangeland is tested for fungi, there will be higher levels found in that soil because of the lack of disturbances to the land.

Test 2 – Determining the Sweetener Preferences of Harvester Ants

If given a choice of sweet nectars, (cane sugar, corn syrup, molasses, honey), then harvester ants will show a preference towards a particular kind – molasses. Watching ants carry milo (grain sorghum from which molasses is made) away from a pile and underground is the reason for this hypothesis.

Test 3 – The Effects of Humic Acid on Seed Germination

If humic acid is applied to seeds during germination, then more seeds will sprout and seedlings will show greater growth. Since humic acid is an organic material, it will directly contribute to the health of the seed from the beginning.

Test 4 – The Effects of Mycorrhizae Fungi on Seed Germination

If mycorrhizae fungi is applied to seeds prior to germination, then plant growth and root mass will increase as the plant grows. Since mycorrhizae relies on roots for a symbiotic relationship, we do not expect to see a difference in germination rates due to mycorrhizae.

Test 5 – Determining Seed Preferences of Harvester Ants in the Lab
If offered a choice of crop or native grass seeds, (blue grama, sideoats grama, wheat, milo), then harvester ants will prefer milo as the crop seed and blue grama as the native grass seed. If ants in an ant farm in the laboratory prefer blue grama and milo, then ants will also prefer these seeds during a field inventory.

Test 6 – Determining UV Preference of Harvester Ants in the Lab and Field
If ants are given a choice of gathering seeds without a coating and seeds that are coated in a substance that fluoresces under ultraviolet light, then they will gather the seed that fluoresces because of their attraction to UV and ability to see UV light.

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

Please see attached lab reports

Test 1 - Determining Fungal Levels in the Soil of Cochran County

Independent Variable:
The location of soil being tested for fungi is the independent variable in this experiment.

Dependent Variable:
The amount of fungi measured in percent in the soil samples is the dependent variable in this experiment.

Test 2 – Determining the Sweetener Preferences of Harvester Ants

Independent Variable:
The kind of sweetener being tested is the independent variable. (honey, corn syrup, cane sugar, molasses)

Dependent Variable:
The number of ants enumerated when selecting each sweetener is the dependent variable.

Test 3 – The Effects of Humic Acid on Seed Germination

Independent Variable:
The type of coating on the seeds during germination is the independent variable. (humic acid, mycorrhizae, or mycorrhizae + humic acid)

Dependent Variable:
The germination success and the length of the plant will be the dependent variables.

Test 4 – The Effects of Mycorrhizae Fungi on Seed Germination

Independent Variable:
The type of coating applied to the seed pellet will be the independent variable. (mycorrhizae fungi, mycorrhizae + humic acid, or humic acid alone)

Dependent Variable:
The germination success and the length of the plant growth will be the dependent variables in this experiment.

Test 5 – Determining Seed Preferences of Harvester Ants in the Lab and Field

Independent Variable:
The type of crop seed or grass seed gathered by ants is the independent variable in this lab experiment. (milo, wheat, sunflower; blue grama, sideoats grama) The type of crop seed or grass seed gathered by ants in this field inventory is the independent variable in this lab experiment. (milo, wheat, sunflower; blue grama, sideoats grama)

Dependent Variable:
The percentage of seeds of different types gathered by ants is the dependent variable in this lab experiment. The percentage of seeds of different types gathered by ants in this field inventory is the dependent variable.

Test 6 – Determining UV Preference of Harvester Ants in the Lab and Field

Independent Variable: The coating applied to the seeds during the experiment is the independent variable. (Coating fluoresces under ultraviolet light, no coating)

Dependent Variable:
The percent of seeds gathered that fluoresce under ultraviolet light is the dependent variable.

(6) How did you measure the validity of your hypothesis?

Please see attached lab reports for details about the validity of these experiments.

Test 1 - Determining Fungal Levels in the Soil of Cochran County

If the collected soils from cotton fields have less than 50% fungal growth after culturing, our hypothesis will be considered valid. According to microbiologist Dr. Karen Little of Sul Ross University, fungi is ubiquitous and cultures should show near 100% coverage for healthy soil.

Test 2 – Determining the Sweetener Preferences of Harvester Ants

Our hypothesis will be considered valid if harvester ants show a 30% preference for a particular sweet nectar during testing.

Test 3 – The Effects of Humic Acid on Seed Germination

If humic acid improves seed germination success by greater than 20% against the other coatings, it will be considered a valid treatment for seeds.

Test 4 – The Effects of Mycorrhizae Fungi on Seed Germination

If mycorrhizae improves seed germination success by greater than 20% of the other coatings, it will be considered a valid treatment for seeds.

Test 5 – Determining Seed Preferences of Harvester Ants in the Lab and Field

If harvester ants show a 30% preference for a particular seed, it will be considered a valid preference. If harvester ants show a 30% chance of selecting a particular seed during a field inventory, it will be considered a valid preference for that seed.

Test 6 – Determining UV Preference of Harvester Ants in the Lab and Field

If harvester ants select seeds coated in a substance that fluoresces under UV light greater than 50% of the time, then their attraction to UV will be considered valid.

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.).

Please see attached lab reports for complete details on each experiment and the materials used.

Test 1 - Determining Fungal Levels in the Soil of Cochran County

Global Positioning System
Google Earth
Plastic bags for soil collection
Field data forms and labels
Gloves
Goggles

Petri dishes
Saucepan and wood spoon
Hotplate
Nutrient agar
Triple beam balance
Beakers
Metric measuring spoons
Filtered water
Calculator
Shovel
Field guide
Camera
Thermometer
Incubator
Grid paper for counting colonies

Test 2 – Determining the Sweetener Preferences of Harvester Ants

Gloves
Goggles
Distilled Water
Triple beam balance
Digital balance
Pipette
Refractometer for measuring Brix of glucose
Beakers
Graduated Cylinders
Metric measuring spoons
Calculator
Digital Camera
ExCel spreadsheet program
Online Videos on serial dilutions
Corn Syrup
Molasses
Sugar
Honey
Cups
Labels
Harvester ants
Timing device

Test 3 – The Effects of Humic Acid on Seed Germination

Gloves
Goggles
Distilled Water
Triple beam balance
Digital balance
Pipette
Beakers Incubator
Thermometer
Graduated Cylinders
Metric measuring spoons
Calculator
Digital Camera
ExCel spreadsheet program
Milo seed
Wheat seed
Sunflower seed

Blue grama seed
Sideoats grama seed
Mycorrhizae fungi
Humic acid
Bags with towels
Labels
Harvester ants
Timing device

Test 4 – The Effects of Mycorrhizae Fungi on Seed Germination

Gloves
Goggles
Distilled Water
Triple beam balance
Digital balance
Pipette
Beakers Incubator
Thermometer
Graduated Cylinders
Metric measuring spoons
Calculator
Digital Camera
ExCel spreadsheet program
Milo seed Wheat
seed Sunflower
seed Blue grama
seed
Sideoats grama seed
Mycorrhizae fungi
Humic acid
Bags with towels
Labels
Harvester ants
Timing device

Test 5 – Determining Seeds Preferences of Harvester Ants in the Lab and Field

Gloves
Goggles
Distilled Water
Black light for viewing ultraviolet-coated seeds
Triple beam balance
Digital balance
Pipette
Beakers
Field notebook
Binoculars
Graduated Cylinders
Metric measuring spoons
Calculator
Digital Camera
ExCel spreadsheet program
Milo seed Wheat
seed Sunflower
seed Blue grama
seed
Sideoats grama seed

Mycorrhizae fungi
Humic acid
Corn Syrup
Molasses
Sugar
Honey
Cups Labels
Harvester ants
Timing device

Test 6 – Determining UV Preference of Harvester Ants in the Lab and Field

Gloves
Goggles
Distilled Water
Triple beam balance
Digital balance
Pyranine (fluoresces in ultraviolet light)
Pipette
Beakers
Field notebook
Binoculars
Graduated Cylinders
Metric measuring spoons
Calculator
Digital Camera
ExCel spreadsheet program
Milo seed Wheat
seed Sunflower
seed Blue grama
seed
Sideoats grama seed
Mycorrhizae fungi
Humic acid
Corn Syrup
Molasses
Sugar
Honey
Cups Labels
Harvester ants
Timing device

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

Please see attached lab reports for complete details about all variables, control groups, and constants.

Test 1 - Determining Fungal Levels in the Soil of Cochran County

Control –

A control Petri dish containing only agar will be tested alongside each soil sample being placed in the incubator so that a fair comparison can be made.

Constants –

Follow the written procedures carefully for every sample used during the lab.
Keep all measurements, temperature, and timing the same for every sample.

Test 2 – Determining the Sweetener Preferences of Harvester Ants

Constants –

The same amount of filtered water.
The same amount of the sweeteners.
Same size of cups.
Check Brix of all the sweeteners 5 times each.
Clean the refractometer each time.
Stir the sweetener until the sweetener has dissolved.

Control –

Compare each of the sweeteners with an equal amount of distilled water when testing the preferences of harvester ants

Test 3 – The Effects of Humic Acid on Seed Germination

Constants – Amount of seeds in each towel - 10
Amount of mycorrhizae (.5 ml + 4 ml H20) and humic acid on each towel (15 ml), each tested separately
Amount of time left in the incubator
Heat of the incubator (27C)

Control –

A control will be tested alongside each seed germination sample. It will contain seeds only, and none of the humic Acid or mycorrhizae Fungus. This untreated packet of seeds would be used to compare the effectiveness of the humic acid and mychorrizae on seed germination.

Test 4 – The Effects of Mycorrhizae Fungi on Seed Germination

Constants –

Amount of seeds in each towel - 10
Amount of mycorrhizae (.5 ml + 4 ml H20) and humic acid on each towel (15 ml), each tested separately
Amount of time left in the incubator
Heat of the incubator (27C)

Control –

A control will be tested alongside each seed germination sample. It will contain seeds only, and none of the humic Acid or mycorrhizae Fungus. This untreated packet of seeds would be used to compare the effectiveness of the humic acid and mychorrizae on seed germination.

Test 5 – Determining Seeds Preferences of Harvester Ants in the Lab and Field

Constants –

The same amount of seed used by mass
The same amount of molasses used for coating pellets
Same amount of mycorrhizae fungi applied to pellets
Same day and time of testing to control weather variables
Seeds placed the same distance and direction from the ant mound entrance

Control –

The control was conducted in the lab. Ants were given the same options of blue and side oats grama. We will compare the ants’ preference to the results in the laboratory-controlled situation.

Test 6 – Determining UV Preference of Harvester Ants in the Lab and Field

Constants –

Same amount of pyranine on each seed type
Same amount of seed used for testing
Same amount of time for observations

Control – An untreated seed was used as the control

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

Please see attachments: Lab Reports and Photo Essays

The number of experiments and variables tested during this 10-month project makes it difficult to read the lengthy experimental procedures in this text box.

Please see the complete experimental process in detail in each of our attached lab reports. Complete details are given in those attachments. There is a brief PowerPoint/PDF presentation to accompany every lab investigation and these include short descriptions and photos of the team working on that experiment.

Test 1 - Determining Fungal Levels in the Soil of Cochran County

Procedure for Gathering Soil Material:

1. Record all soil locations by using a GPS unit and Google Earth.
2. Collect 50 ml of soil from each location, being careful to select soil that is representative of the location identified.
3. Place each soil sample into separate, properly labeled Zip-Lock bags.
4. Label each bag with the name of the soil, the general location name, and record this in the field journal.

Procedure for Pouring Petri Plates:

1. Mass 12 grams of nutrient agar using a digital scale.
2. Add to 0.5 liter of distilled water and mix until evenly dispersed.
3. Heat with repeated stirring and boil for one minute to dissolve the agar completely.
4. Quickly and carefully tip the lid of the Petri dish open and add 1 ml of agar to the dish using a pipette.
5. Replace the lid and allow the agar to harden.

Procedure for Culturing Soil Fungus

1. Place 1 ml of soil on the surface of nutrient agar that is in Petri dishes.
2. Then, culture the plates for 72 hours.
3. Take pictures and record notes every 24 hours.
4. After the 72 hours, determine the amount of fungus on each plate using grid paper.
5. Convert the number of grids containing fungal spores into the percentage of fungus in each Petri dish.
6. Record data using tables, graphs, and charts.
7. Analyze each kind of soil for the amount of fungi present.
8. Record qualitative and quantitative data.
9. Record results, conclusion, and next steps in experimentation.

Test 2 – Determining the Sweetener Preferences of Harvester Ants

Lab Report is attached

Test 3 – The Effects of Humic Acid on Seed Germination

Lab Report is attached

Test 4 – The Effects of Mycorrhizae Fungi on Seed Germination

Lab Report is attached

Test 5 – Determining Seeds Preferences of Harvester Ants in the Lab and Field

Lab Report is attached

Test 6 – Determining UV Preference of Harvester Ants in the Lab and Field

Lab Report is attached

Data Collection and Analysis

(10) Describe the data you collected and observed in your experiment. The use of data tables, charts, and/or graphs are encouraged.

Please see attachments – Lab Reports and Data Tables/Charts/Graphs

The complete descriptions of the data collected and observed can be found in each of the attached lab reports, including data tables, charts and graphs. ExCel files are also attached for your convenience.

Test 1 - Determining Fungal Levels in the Soil of Cochran County

Test 2 – Determining the Sweetener Preferences of Harvester Ants

Test 3 – The Effects of Humic Acid on Seed Germination

Test 4 – The Effects of Mycorrhizae Fungi on Seed Germination

Test 5 – Determining Seeds Preferences of Harvester Ants in the Lab and Field

Test 6 – Determining UV Preference of Harvester Ants in the Lab and Field

(11) Analyze the data you collected and observed in your experiment. 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...'

Please see attachments – Lab Reports

The attached lab reports include an analysis of the data we collected for each experiment, as well as its application.

Test 1 - Determining Fungal Levels in the Soil of Cochran County

Our data refutes the hypothesis concerning the most fungi in the soil. We believed that the Native Grassland would have the most fungi in the soil, but the Natural Playa had more.

Our data supports the hypothesis concerning the least amount of fungi. The Harvested Cotton Field had the least amount of fungi in the soil, as hypothesized.

Test 2 – Determining the Sweetener Preferences of Harvester Ants

The data supported our hypothesis that said that harvester ants would prefer molasses since it was made from grain sorghum/milo which we know to be attractive to ants from our experience.

Test 3 – The Effects of Humic Acid on Seed Germination

The data refuted our hypothesis. We believed a combination of humic acid + mycorrhizae would provide the greatest germination success. In the tests, humic acid alone performed better.

Test 4 – The Effects of Mycorrhizae Fungi on Seed Germination

The data supported our belief that mycorrhizae fungi would have a better effect after plant development and not during seed germination.

Test 5 – Determining Seed Preferences of Harvester Ants in the Lab and Field

The data supported our hypothesis that harvester ants would choose milo as the preferred crop seed and blue grama as the preferred native seed.

Test 6 – Determining UV Preference of Harvester Ants in the Lab and Field

The data supported our hypothesis that the harvester ants would gather more seeds with a fluorescent coating than those without a coating.

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

Every experiment has sources of error and although good scientists try to keep these to a minimum, they do affect results. During the seed germination experiment, constants were maintained and a control was included for comparison with the experimental groups. Despite using ten seeds in each of three trials, the results may contain some errors. The cost of crop seed can be expensive; therefore, we used milo and wheat seed that is sold together as scratch seed. For this reason, the low germination rates in two of the trials may be the result of error. There is the possibility that a higher percentage of seeds were unviable than what would have occurred in more expensive crop seed. When analyzing these data and drawing conclusions, this information was kept in mind.

During the experiment to determine the food preference of harvester ants, an ant farm was used in the classroom to house ants purchased from Ward's Scientific, Incorporated. Harvester ant is a common name that describes several species of ants that are seed gatherers. The behavior of one species (the one we purchased and tested in the ant farm) may not match the behavior of the species in the fields of our community. This could result in a source of error in the food preferences. To deal with this possibility, the experiment was conducted both in the laboratory and in the field, using both species of harvester ants.

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?

Conclusion Statement –

The experiment results of Ants Go Marchin' support the hypothesis that fungi is a key player in soil health and in restoring health to dead dirt. Soils in our region were depleted of fungi, particularly on land that had been farmed for decades, as supported by our data. After learning this, two primary ingredients in rebuilding soil were applied to seeds and it was found that both humic acid and mycorrhizae had positive effects on plants. Humic acid helped during the germination period and mycorrhizae would be more useful as roots were becoming established. When moving on to experiments involving the use of ants in restoring fungi to the soil, our hypotheses were supported when the results showed that ants prefer milo seed or blue grama seed coated in mycorrhizae + molasses + pyranine (fluoresces under UV light). The test results were useful in determining the kinds of seeds to use for the pellets, the combinations of materials to include in the coating, and in the effectiveness of insects in dispersing fungi to improve soil health. Additional tests include re-sampling soil and testing it for fungal levels following a period of three, six, nine, and twelve months during which mycorrizae was added to farm land and grasslands. We have already fenced off an area of the Aday WTX Ranch that is native grassland so that we have an accurate picture of the soil and plant life before experimentation begins in April.

In both the lab setting and in the field inventory, seed preferences remained true for the harvester ants. Insects likely gather different kinds of seeds at different times of the year; therefore, we want to retest in late spring, summer, and fall. Our new hypothesis will state that if harvester ants gather milo seeds in winter, sunflower seeds in summer, and wheat in fall, then ants show a preference for the crop that is ready to harvest during that particular season. It remains important for the team to know seed preferences of ants so that they will gather the most seeds coated in mycorrhizae and disperse seed and fungi more rapidly. Our experimental design will be expanded to include more sites with active harvester ant colonies and the use of a highly sensitive game camera to assist in observations over a longer period of time.

The longer a plant is growing in the soil, the greater the benefit of the mycorrhizae to the plant roots and to the soil itself. The fungi will allow the plant roots to collect and retain more moisture. The deeper the root and the healthier the root is helps maintain a higher moisture content for the crop. The data showed that seeds germinated faster and established roots first when the humic acid was in the soil. The mycorrhizae will provide a benefit as the plant is further established in the soil.

The restoration of a short grass prairie provides many benefits to this region. Wind erosion is decreased with the plant life added to the soil. The buffer of native grasses planted around a playa wetland protects the wetland from water erosion and sedimentation. As the major source of recharge for the Ogallala Aquifer, a healthy playa wetland is critical to this region.

To benefit the ranchers, the more grass and the healthier the grassland, the more heads of cattle can be supported, and the more weight the cattle can gain. On average, 1.4 pounds per day can be increased to 1.8 pounds per day by establishing healthier grasslands.

Local gardeners would benefit as well by using the information we gained in this project. The addition of mycorrhizae to the soil would lead to deeper roots, meaning less water would be needed for the garden. Economic benefits come from water conservation. Plants would be healthier, more disease resistant, require less herbicides and pesticides, and withstand drought more effectively. Our Ecybermission team contacted other middle school students responsible for planting, nurturing, and harvesting a community garden and there was great interest in combining the two projects as a benefit to both groups.

Uploaded Files:

- [**View**] **Sweetener Preference Photo Essay** (By: Happydr, 03/04/2014, .pptx)

  This photo essay shows the team working on the serial dilution of the various sweeteners that a harvester ant might prefer. It includes photos of the ant farm, the use of the refractometer, and the preparation of the concentrations of sugar, molasses, honey, and corn syrup.

- [**View**] **UV Light + Ants Photo Essay** (By: Happydr, 03/04/2014, .pptx)

  A photo essay showing the team preparing the seed pellet with pyranine that fluoresces in ultraviolet light. This accompanies the lab report about the ants' ability to see in UV.

- [**View**] **Native Grassland Restoration Photo Essay** (By: Happydr, 03/04/2014, .docx)

  A photo essay shows the collaboration between the team and Texas Parks and Wildlife, US Fish and Wildlife Service, and the WTX Ranch. The team build fenced enclosures to allow for testing of fungi and plant surveys in an area untouched by grazing. This will allow for accurate comparisons of our restoration of native grasses and those plants growing inside enclosures.

- [**View**] **Seed Germination Photo Essay** (By: Happydr, 03/04/2014, .pptx)

  A photo essay to accompany the lab report on the effects of mycorrhizae and humic acid on seed germination. Photos show the team preparing the seeds with coatings and viewing the initial results of the germination project.

- [**View**] **The Effect of Mycorrhizae and Humic Acid on Seed Germination Lab Report** (By: Happyhf, 03/04/2014, .docx)

  This lab report contains all the details of the experiment performed. It includes purpose, hypothesis, background information, variables, constants and controls, quantitative data, data tables, charts, graphs, results, and conclusions. The photos of this experiment can be found in the photo essay attached on seed germination.

- [**View**] **The Amount of Fungi in Cochran County Soil Lab Report** (By: Happyhf, 03/04/2014, .docx)

  This lab report contains all the details of the experiment performed. It includes purpose, hypothesis, background information, variables, constants and controls, quantitative data, data tables, charts, graphs, results, and conclusions. The photos of this experiment can be found in the photo essay attached on soil fungi.

- [**View**] **Harvester Ants Preference of Sweeteners through a Serial Dilution Experiment - Lab Report** (By: Happyhf, 03/04/2014, .docx)

  This lab report contains all the details of the experiment performed. It includes purpose, hypothesis, background information, variables, constants and controls, quantitative data, data tables, charts, graphs, results, and conclusions. The photos of this experiment can be found in the photo essay attached on sweeteners.

- [**View**] **Ultraviolet Light - Effects of Pyranine on an Ants' Preference for Seeds - Lab Report** (By: Happyhs, 03/04/2014, .docx)

  This lab report contains all the details of the experiment performed. It includes purpose, hypothesis, background information, variables, constants and controls, quantitative data, data tables, charts, graphs, results, and conclusions. The photos of this experiment can be found in the photo essay attached on ants and UV.

- [**View**] **Seed Preference in a Field Inventory Lab Report** (By: Happyhs, 03/04/2014, .docx)

  This lab report contains all the details of the experiment performed. It includes purpose, hypothesis, background information, variables, constants and controls, quantitative data, data tables, charts, graphs, results, and conclusions.

- [**View**] **Measuring Fungi in Soil Photo Essay** (By: Happyhs, 03/04/2014, .pptx)

  A photo essay showing the team's work in collecting soil samples, making culture plates with nutrient agar, culturing for fungi, counting fungal colonies, and determining that fungi is missing from our agricultural soils.

- [**View** **Bibliography** (By: Happydr, 03/04/2014, .docx)

]

Bibliography

- [**View**] **Contact List** (By: Happydr, 03/04/2014, .docx)

Those subject matter experts who are most familiar with our project and provided the help we needed this year are listed on this document, along with their email address.

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.

Please see attachments: Website Link, Brochure, Flyer, Map of Aday WTX Ranch

“We are part of the earth and it is part of us ... What befalls the earth befalls all the sons of the earth.” --- Chief Seattle, 1852

In order to benefit our community, farmers were contacted and three (Jude Smith, Cliff DeSautell, Corey Ayers) agreed to plant seeds from our team that would give their soil a boost in health. Each seed had a special coating on it. Milo, corn, cotton, and wheat seeds were given a coating of mycorrhizae + humic acid, which we learned during lab tests will germinate faster and in greater numbers than seeds without the coating. Since mycorrhizae only lives in symbiosis with plant roots, it makes sense to apply the fungi to seeds that will sprout and immediately meet the needs of the fungi. As plants take root in the soil, they will carry with them the life-giving mycorrhizae.

Outreach opportunities are growing for our team through the use of brochures that educate others about the need for healthy soil and steps than can be taken to put beneficial fungi back into the soil. Public presentations are given to groups interested in soil, land management, gardening, and agriculture. Through a conservation non-profit organization “Ogallala Commons,” speaking engagements allow us to teach adults how to improve soil health and teach students ways to become involved in research and experimentation through Ecybermission. Please visit our website for more information. http://healthysoil.weebly.com

Implementation is being planned in the field for the months of April and May, after the last frost. The WTX Ranch is the test site for experimentation in restoring native grassland. On this site, ants will be used to encourage faster spread of native plants. Sideoats grama and blue grama seed will have mycorrhizae + molasses + a UV substance applied to them in order to encourage the ants to collect and spread the seed more readily. Biologists from the US Fish and Wildlife Service and Natural Resources Conservation Service have contacted the team in order to use these “pellets” to regrow native grasses on areas in recovery from farming. A new hypothesis will be, “If mycorrhizae and humic acid are added to the soil in an area set aside for restoration, then native grasses will provide full coverage faster than areas without the inoculation of fungi and humus. As ants move the seed pellets through the ground, plant roots will be established, thus improving soil health through fungi coatings.” This innovative coating that was developed by our team could help do more than restore grasslands. Fungi could become a significant player in climate change.

The mycorrhizae fungi that is being put back into depleted soil, may help limit global warming. Scientists in Sweden recently discovered that 70% of the carbon bound in soil is not from decaying tree leaves and branches as once thought. The carbon is actually bound in soil from the roots and mycorrhizae fungi that are in a symbiotic relationship with those roots. The prairie soil, if healthy, could store a large amount of carbon, thus helping limit global warming. As native grasslands increase in the amount of mycorrhizae found in the soil, then an increase in carbon could be measured in these “carbon sinks” as well. Decomposition releases carbon back into the atmosphere through the cycle of carbon, but additional studies are suggesting that fungi plays a greater role in storing carbon, than in releasing it. Future experimentation will involve measuring amounts of carbon in the soil and comparing soil rich in mycorrhizae with those that are depleted.

Stewardship of the land is the responsibility of each of us. Essentially, all life depends upon the soil. Restoring the living components of soil to the fields and aiding in the expansion of the short grass prairie benefits our community, as well as others.

In the words of Aldo Leopold in A Sand County Almanac, “We abuse land because we regard it as a commodity belonging to us. When we see land as a community to which we belong, we may begin to use it with love and respect.”

Uploaded Files:

- [**View**] **Poster for a Public Presentation** (By: Happyhf, 03/04/2014, .pdf)

This poster was used to gain attention for the public presentation we gave to inform people in the community about the importance of soil health.

- [View] **Brochure - Soil Health** (By: Happyhf, 03/04/2014, .pdf)

  This brochure was distributed to people in the community and at conferences. The purpose was to tell them about the work of this team and the importance of maintaining a healthy soil. In our agricultural community, this issue is of great importance.

- [View] **Native Grassland Restoration - Aday WTX Ranch** (By: Happyhf, 03/04/2014, .docx)

  Areas of the 500 acre ranch are in need of grassland restoration because of overgrazing by beef cattle. Our team will begin the process of seeding the area and spreading pellets coated in mycorrhizae for the ants to disperse as well. Areas for the control have already been fenced off as a comparison and restoration is scheduled for April 2014.

- [View] **Website - Ants Go Marchin'** (By: Happydr, 03/04/2014,)

  Our team website can be accessed here: http://healthysoil.weebly.com

Ants Go Marchin' 2 x 2

Team Responsibilities

Interview Farmers - trilingual(English, German,Spanish)	Prepared Data for Sugar Concentration Experiment	Artistic - Design logo	Interviewed Scientists
Bibliography- Contact Lists	Editor- Writer- Brochures	Prepared the Ant Farm for the Harvester Ants	Collected Native Seeds
Photography Coordinator	Photographer	Photographer	Collected and Sorted Crop Seeds
Team Notebook Organizer	Research- Mycorrhizae Fungi	Research - Harvester Ants	Research - Pesticides & Herbicides
Prepared Sugar Concentration - Corn	Prepared Sugar Concentration - Sugar	Prepared Sugar Concentration- Molasses & Honey	Conducted Field Experiments with Harvester Ants
Collected Soil from Upland	Collected Soil Harvested Fields	Collected Soil from Grasslands	Collected Soil from Playas
Counted Fungus in Petri dishes	Counted Fungal Colonies	Counted Fungus in Petri dishes	Native Grassland Restoration
Aday Ranch - Fenced off sections for Restoration	Public Speaker during Presentations	Public Speaker during Presentations	Data Analysis and Standard Deviation
Prepared Prezi and Power Points	Coordinator for the SerialDilution Lab	Coordinator for the Seed Germination Lab	Coordinator for the Seed Preference Lab

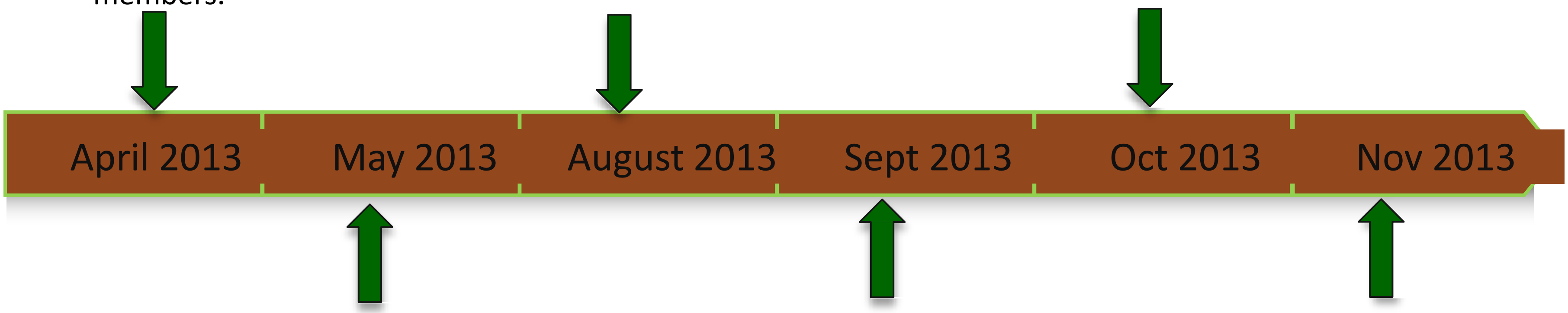
Ants Go Marchin'!

Timeline for eCYBERMISSION Project

Team Forms
The teams are beginning and choosing the members.

Ecybermission Registration
Team was completed with members George, Hudson, Christina, and Davis accepting the challenge.

Meeting with Experts Met with Dr. Bill Jones and Refuge Manager Jude Smith about environmental issues



Team and Action Plan Development
Research & decisions about the direction of the team and experiments for 7th grade

Team Meetings – Responsibilities and Schedules
Identified strengths of each team member

Chose the Topic – Soil Health
Research on soil health, bacteria, and fungi

April 2013 ~ May 2014

Ants Go Marchin' Timeline Continued ….

Making Team Meeting and Shedules
Scheduled times for meetings for Dec, Jan, Feb. Divided responsibilities

Analyzing the Experimentation
Analyzing data from experiments with humic acid, mycorrhyzae fungi, and ants as carriers

Restoring Native Grassland
Native Grassland to be restored on the Aday Ranch as weather warms. US Fish and Wildlife Service partners with the team

Dec 2013 | Jan 2014 | Feb 2014 | March 2014 | April 2014 | May 2014

Aday Ranch
At the Aday Ranch we met Dr. Aday, TX Parks & Wildlife, US Fish & Wildlife about field work on the ranch

Agricultural Information
Presentations planned to gain support of farmers in improving

Not Over YET
Therefore this project will go on. Its not over yet.

PHOTO ESSAY OF SWEETENER PREFERENCES OF HARVESTER ANTS

Presented by:

Ants Go Marchin' 2 by 2

A STEM Research in Action Team


The materials used for the sugar concentrations
Karo
Great Value
Pure Sugar
15 Calories
Corn Syrup
Sugar
Molasses

Four types of natural sweetener were prepared in a serial dilution lab. The purpose was to determine which concentration of sweetener was preferred by harvester ants.

Corn Syrup Concentrate

Sugar Concentrate

Molasses Concentrate

Honey Concentration

The team members collecting data with a refractometer. A refractometer measures Brix of glucose.

DI LUTIONS

.1
.01
.001
.001

Serial dilutions
were tested
using harvester
ants. The
preferred
co nee ntra tion
and sweetener
was .1% of
molasses.

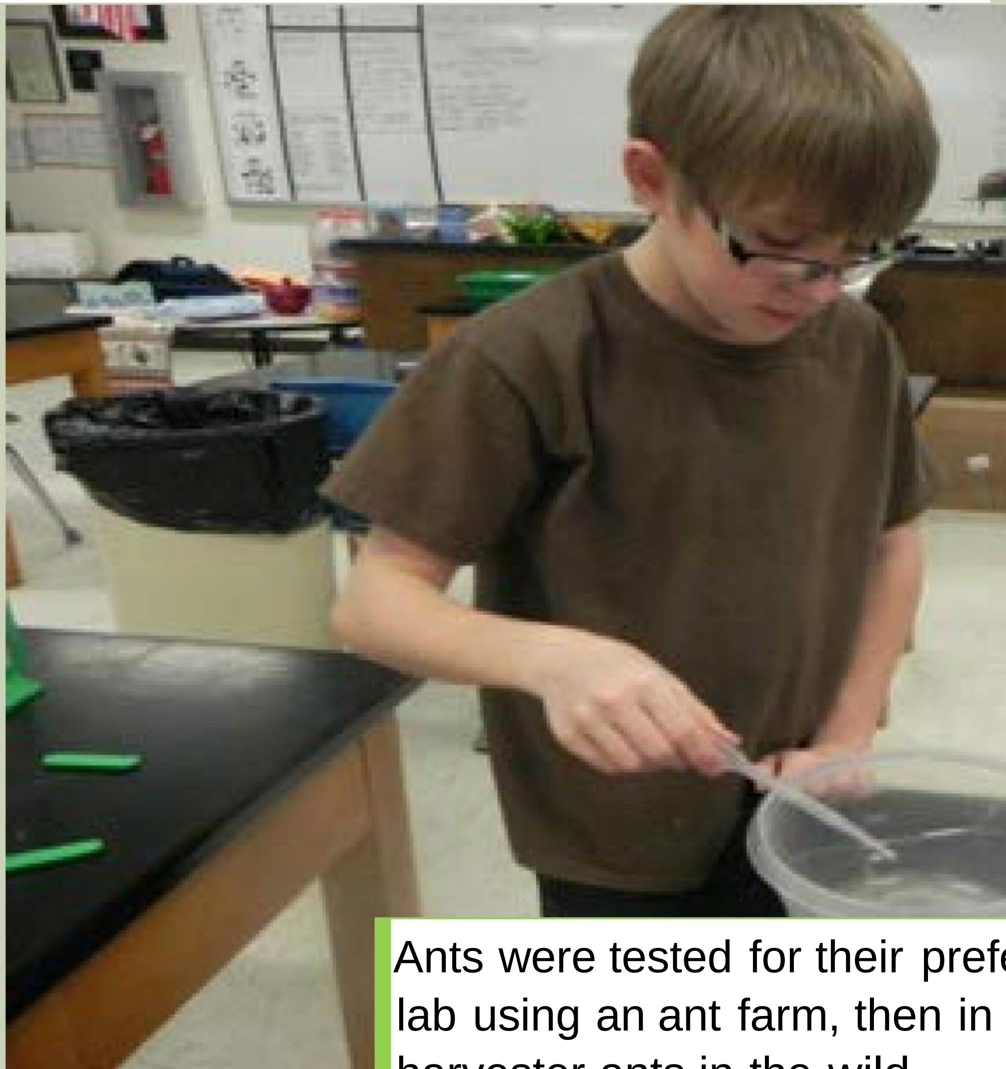
his supports o
hypothesis tha
molasses woul
e preferre
because
olasses
ade from gra
sorghum and
hat is found
crops
ighou
region. The ants
are often seen
in the sorghum
seed.

Team Members used the refractometer to measure the Brix of each liquid. Determining the ideal concentration as chosen by ant preference would be essential in developing a pellet that ants would help spread.

Team Member using a scientific calculator to determine the comparable data for each of the

sweet concentrations.

Building a bridge to reach the molasses – the preferred sweetener for the harvester ants.



Ants were tested for their preference first in the lab using an ant farm, then in the field with harvester ants in the wild.

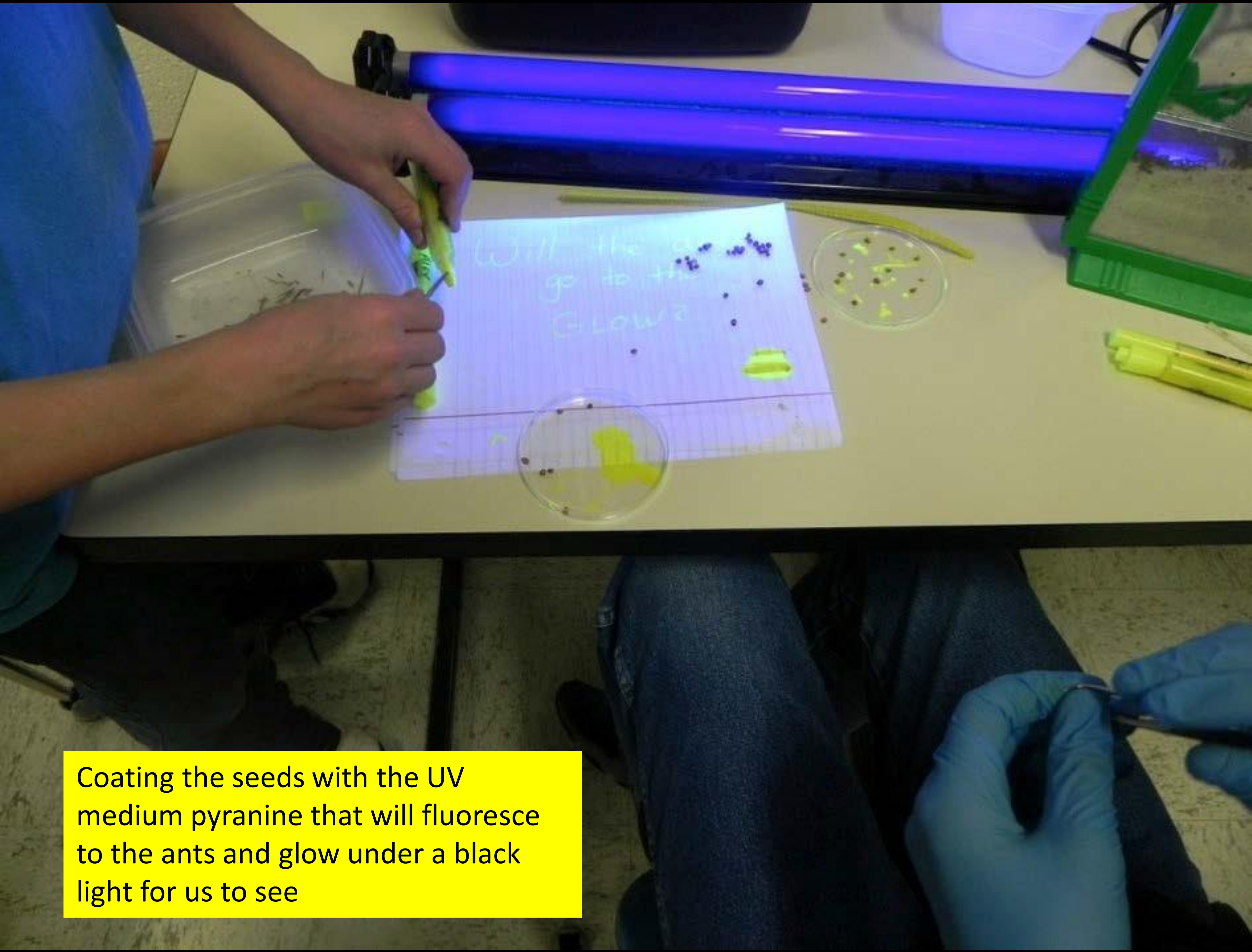
Team Members observing the ants to determine which substance they prefer .

Photo Essay of UV Experiment

Presented by:

Ants Go Marchin'

A STEM Research and Action Team



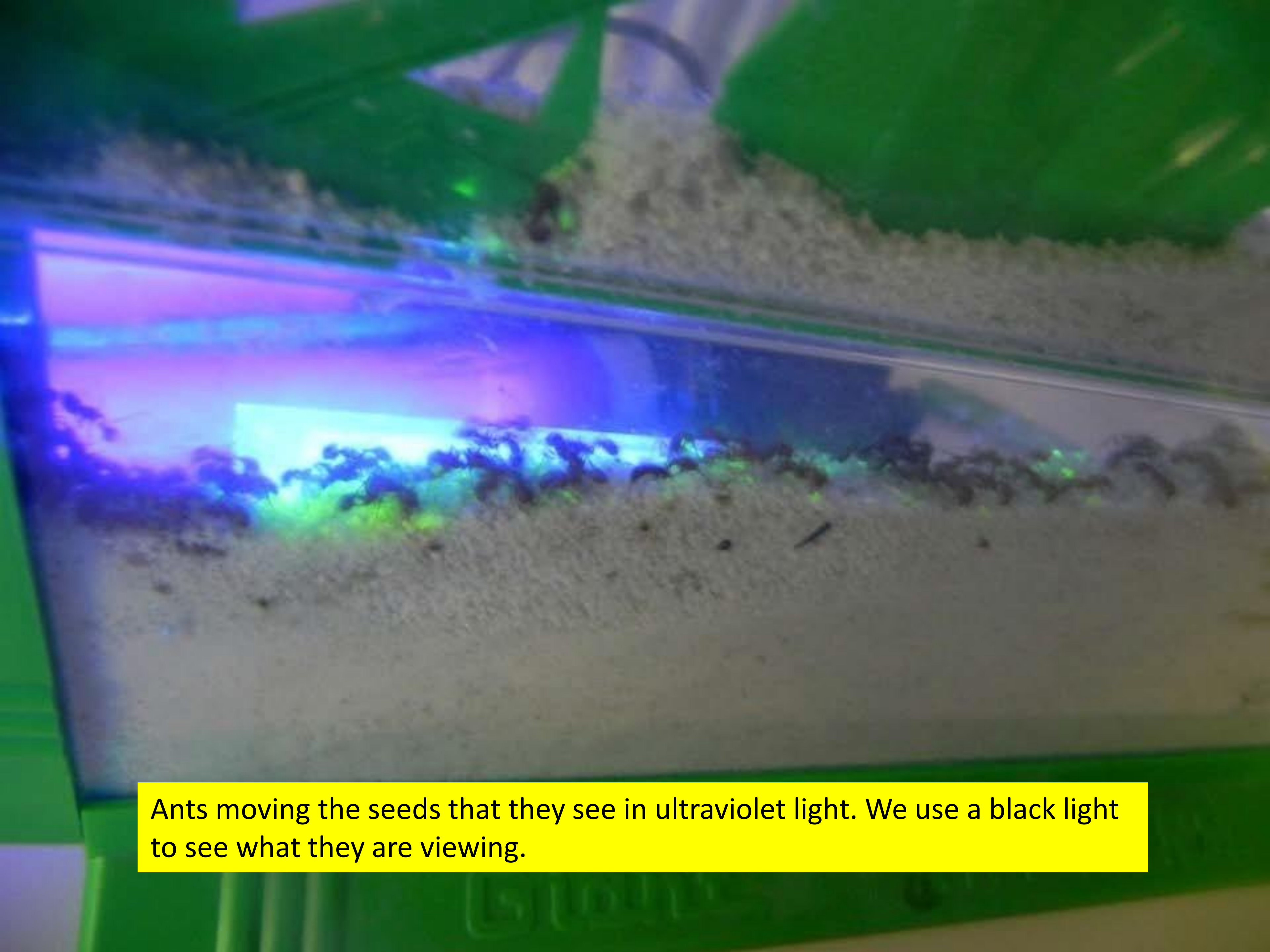
Coating the seeds with the UV medium pyranine that will fluoresce to the ants and glow under a black light for us to see

Placing seeds coated with UV medium into the ant farm.

Dropping in some seeds that have been dipped in UV medium

Watching the ants in the UV light.

Ants being drawn to the seeds with pyranine which fluoresces.



Ants moving the seeds that they see in ultraviolet light. We use a black light to see what they are viewing.

Watching the ants move materials around, setting up their colony.

Hudson watching the ants in UV light

Restoring Native Grassland

A Day at the Aday WTX Ranch

Presented by:

Ants Go Marchin'

A STEM Research and Action Team

Ecybermission 2014

The Texas Parks and Wildlife biologist Russell Martin learning about native plants and their importance to short grass prai:rie

Teammates driving the fence post to erect an of native grasses. This will allow the team to [illegible] fungi [illegible] in an undisturbed area *vs.* a grazed area *vs.* a [illegible] using mycorrhizae and humic acid.

The Parks and Wildli:fe

US Fish & Wildlife

Dr. Lu Ann Aday

Aday WTX Ranch

Natural Resources Conservation Service

Ogallala Commons

Muleshoe National Wildlife Refuge

Collaborations

The Effects of Mycorrhizae and Humic Acid on Seed Germination

PRESENTED BY:

Ants Go Marchin'

Preparing the seeds to be tested.

The team weighing the seeds to be tested

Team Member preparing paper towels for the experiment with the seeds.

Team Member preparing the paper towels for the other team members.

Team Member adding humic acid to the paper towel

Sunflower seeds in humic acid.

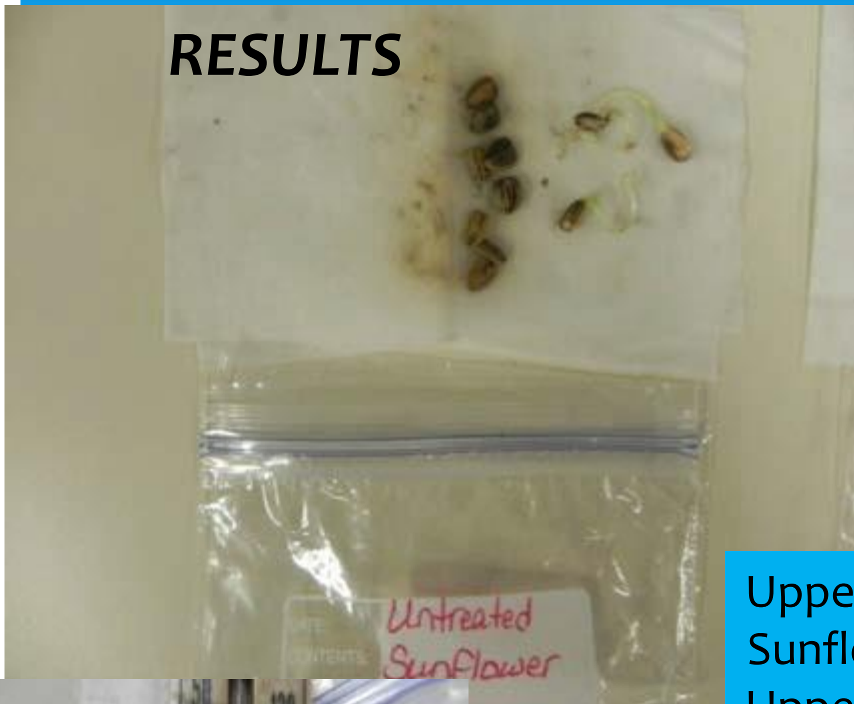
humic acid used in project.

Milo seeds in humic acid.

Team Member adding mycorrhizae to the bowl of water

The team coating the seeds with mycorrhizae.

RESULTS



Upper Left: Untreated Sunflower
Upper Right: Untreated Wheat
Lower Right: Untreated Milo

TESTS WERE CONDUCTED AT A CONTROLLED TEMPERATURE IN AN INCUBATOR.

RESULTS

All specimens were treated with Myccohrizae.

Upper Left: Mycorrhizae Sunflower
Lower Left: Mycorrhizae Wheat
Upper Right: Mycorrhizae Milo

Results

All specimens were treated with Humic Acid

Upper Left: Humic Acid Milo
Lower Left: Humic Acid Sunflower
Upper Right: Humic Acid Wheat

Results

All specimens were treated with Mycorrhizae and Humic Acid

Upper Left: Mycorrhizae and Humic Acid Wheat
Lower Left: Mycorrhizae and Humic Acid Milo
Lower Right: Mycorrhizae and Humic Acid Sunflower

The Effect of Mycorrhizae and Humic Acid on Crop Seed and Grass Seed Germination

Photo Credit by Morning-Earth Organization

7th Grade STEM Research in Action eCYBERMISSION Competition 2013 – 2014

Experimental Design Diagram

TITLE	**Effects of Mycorrhizae & Humic Acid on Seed Germination**		
HYPOTHESIS	We think that the combination of mycorrhizae and humic acid will allow the seeds to germinate more successfully and show greater plant growth.		
INDEPENDENT VARIABLE	The independent variable is the substance applied to the seeds. **Only one variable was manipulated at a time.**		
NAMES OF INDEPENDENT VARIABLES	Sunflower seeds	Wheat seeds	Milo seeds
TRIALS OR TESTS PERFORMED	30	30	30
DEPENDENT VARIABLE	The dependent variable is length of the germinated seedlings exposed to each of the experimental variables compared to the control		
CONSTANTS	• Amount of seeds in each towel - 10 • Amount of mycorrhizae (.5 ml + 4 ml H20) and humic acid on each towel (15 ml), each tested separately • Amount of time left in the incubator • Heat of the incubator (27C)		

Introduction:

Wheat, Sunflower, and Milo seeds are all major crop seeds in this native area.We choose these seeds due to idea that we had that the harvester ants would like these seeds.

Purpose or Problem

- Will the mycorrhizae and humid acid help the seed germination in any way possible?
- Does the mycorrhizae affect the plant's seed growth immediately or after the plant's roots are established?

Hypothesis

We think that the combination of mycorrhizae fungi and humic acid will boost seed germination rate. We hypothesize this due to the fact that these two contents help boost soil health by putting beneficial fungi and organic matter back into the soil.

Reasoning

The types of crop seeds chosen are commonly planted in our county.

Safety Precautions:

Do not inhale the fungi.
Wear goggles in case of loose dirt particles.

Materials Needed:

Plastic bags
Seed
Mycorrhizae
Humic Acid
Toweling
Gloves
Goggles

Triple beam balance
Beakers
Metric measuring spoons
Filtered water
Calculator
Seeds
Camera
Thermometer
Incubator

Procedure for Seed Germination

1. Wet 12 paper towels and rinse thoroughly.
2. Then, add 15 ml humid acid to paper towels.
3. Place 10 seeds of the 3 types of seeds you used on paper towels. (4 paper towels for each type of seeds) Sunflower Seeds, Wheat seeds.
4. Leave one paper towel with no mycorrhizae and or humid acid for the control in this experiment.
5. Place into a zip-lock bag.
6. Label bag, for example, " Control Sunflower".
7. Place Mycorrhizae onto one paper towel of each type of seeds.
8. Place into a zip-lock bag.
9. Label the bag, for example " Humic Acid: sunflower".
10. Place the mixture of humid acid and water onto one paper towel of each type of seeds.
11. Place into a zip-lock bag.
12. Label the bag.
13. Mix a combination of Humic Acid and water combination with the Mycorrhizae fungus .
14. Put the combination onto the last paper towel for each type of seeds.

15. Place into a zip-lock bag.
16. Label bag.
17. Place all bags into an incubator at 27 degrees Celsius.
18. Check the seed germination at 72 hours.
19. At 72 hours take the plants out of the incubator and examine the root growth.
20. Record the length of the roots in cm. and also the percentage of seeds that sprouted.
21. Record all data into a data table.

Controls:

A control will be tested alongside each seed germination sample. It will contain seeds only, and none of the humic Acid or mycorrhizae Fungus. This untreated packet of seeds would be used to compare the effectiveness of the humic acid and mychorrizae on seed germination.

Constants:

Follow the written procedures carefully for every sample used during the lab.

Keep all measurements and temperature the same for every sample.
Amount of seeds used for each paper towel.
Amount of humic acid and mycorrhizae fungus applied in each experimental run.

Independent Variable:

The Independent Variable in this project is the conditions for germinating within the baggie. One contained water (control), one contained humic acid, one contained mycorrhizae, and one contained a combination of both mycorrhizae and humic acid.

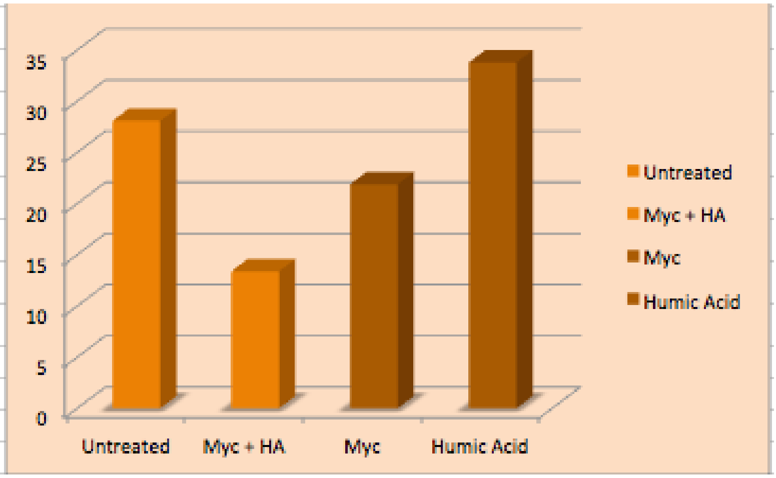
Dependent Variable:

The dependent variables in this project are the percent of seeds germinating and the length of the roots on the seedlings.

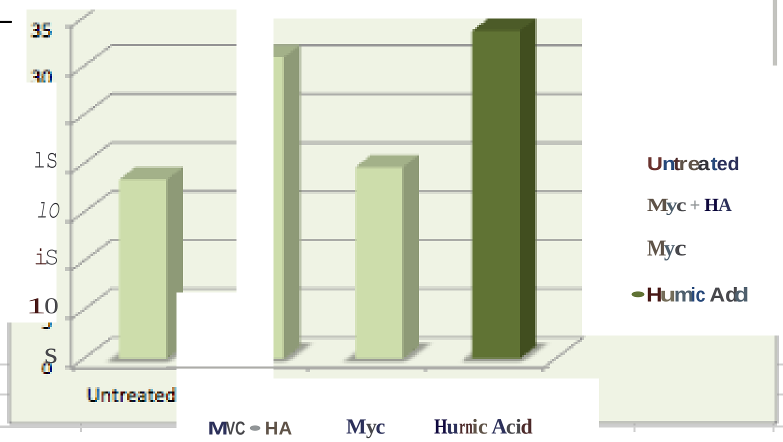
Quantitative Data

Please see “Results” for an explanation of the data collected during the 30 trials.

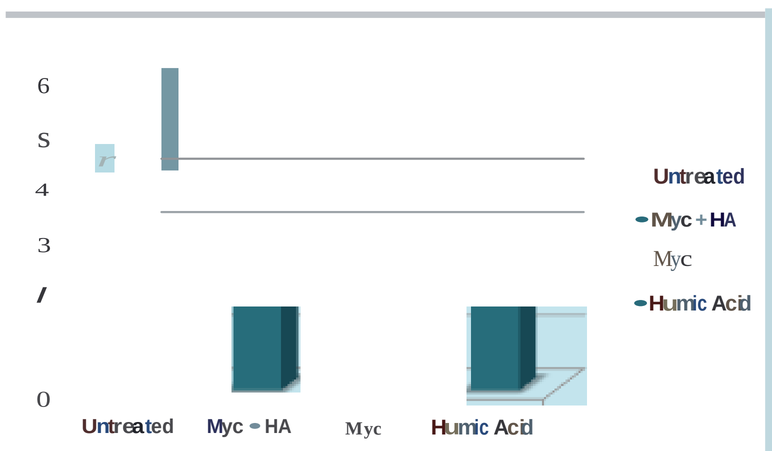
Milo - Sorghum - Maize Seeds Average of 30 Trials per Variable		
Growth Medium	Total Growth cm	Germination Success
Untreated	28.1	40%
Myc + HA	13.4	30%
Myc	21.9	40%
Humic Acid	33.8	50%



Sunflower Seeds- Average of 30 Trials per Variable		
Growth Medium	Total Growth em	Germination Success
Untreated	18.4	30%
Myc+ HA	31	60%
Myc	19.7	30%
Humic Acid	33.7	70%



Wheat Seeds Average of 30 Trials per Variable		
Growth Medium	Total Growth em	Germination Success
Untreated	5.9	20%
Myc+HA	2.9	20%
Myc	0	0%
Humic Acid	2.7	10%



Results:

Sunflower:
Our results of the sunflower conclude that the Humic acid seeds (60%) sprouted nearly 40% more than the control which only had a 30% germination rate.

Wheat:
The results that our group found for the wheat seed were not reliable. We feel the seeds may have been unviable because the seed germination rate was low compared to the other results. Because we used scratch seed and not expensive wheat crop seed, perhaps some of the seeds were not good. We do not feel we can trust the results of the wheat germination.

Milo:
In the humic acid-treated group, 50% of the seeds sprouted. The control group and the mycorrhizae group sprouted at 40%, not far behind the humic acid group. The combination had a lower germination rate at 30%.

From our results, the mycorrhizae was expected to be more effective once a plant root's are established, so it is not surprising that it did little to effect germination. The humic acid was more effective in promoting germination of the seeds.

Conclusions:

Through this test you can conclude that the humic acid itself was a seed germination supporter for the sunflower seeds. We can support this idea with the fact that humic acid-treated seeds had the highest percentage of seeds germinating in the test.

We can also conclude the combination was a supporter to the seed germination due to the fact that the combination's percentages were really close to the humic acid's percentage for sunflower seeds; therefore, making the results comparable with the humic acid results.

Mycorrhizae-treated and untreated seeds performed the same in both the sunflower trials and the milo trials, showing that mycorrhizae's benefits do not occur at germination, but later in the plant's growth.

Determining Fungal Levels in the Soil of Cochran County

7th Grade STEM Research in Action
eCYBERMISSION Competition 2014

Experimental Design Diagram

TITLE	**Measuring the Fungus Levels in Soil of Cochran County**					
HYPOTHESIS	The rangeland soil is expected to have the highest levels of fungus in the soil because no pesticides or herbicides are disturbing it. We think that the harvested cotton field will have the least amount of fungus in the soil because of all the pesticides or herbicides that have been applied to the field.					
INDEPENDENT VARIABLE	The independent variable is the location of the soil and the different type of soil we gathered.					
NAMES OF INDEPENDENT VARIABLES	Center of Playa-Natural	Center of Playa-Farmed	Native Grassland	Harvested Cotton Field	Sandy Berm	Control No Soil
TRIALS OR TESTS PERFORMED	3	3	3	3	3	3
DEPENDENT VARIABLE	The dependent variable is the amount of fungus that we are measuring in each soil.					
CONSTANTS	• The same amount of agar in the Petri dishes • The same amount of soil in the Petri dishes • Same size of Petri dishes • Used identical grid counters • Temperature constant at 37 degrees C					

Introduction:

Fungi perform important services related to water dynamics, nutrient cycling, and disease suppression. Along with bacteria, fungi are important as decomposers in the soil food web. They convert hard-to-digest organic material into forms that other organisms can use. Fungal hyphae physically bind soil particles together and help increase water infiltration and soil water holding capacity.

Soil fungi can be grouped into three general functional groups based on how they get their energy.

- *Decomposers* – saprophytic fungi – convert dead organic material into fungal biomass, carbon dioxide (CO2), and small molecules, such as organic acids. These fungi generally use complex substrates, such as the cellulose and lignin, in wood, and are essential in decomposing the carbon ring structures in some pollutants.
- A few fungi are called “sugar fungi” because they consume the same food source as do many bacteria. Like bacteria, fungi are important for retaining nutrients in the soil.
- In addition, fungi are organic acids, so they help increase the accumulation of humic-acid rich organic matter that may stay in the soil and improve soil health for hundreds of years.

Purpose or Problem

- Do the soils in our county have healthy levels of fungus?
- Have 75 years of pesticide use in farming decreased the amount of fungus in our soil?
- Will there be a difference in fungal levels in soil locations?
- Purpose is to identify soils that contain the least fungi and remediate those soils.

Hypothesis

We think that the harvested cotton field will have the least amount of fungus in the soil because of the amount of pesticides and herbicides that were used on that field. The center of the playa will have a low amount of fungus because there was no buffer around therefor chemicals will run of to the fields and into the playa. The sand will have a low amount of fungus because sand is so dry and seems sterile. The rangeland will have the most fungus in the soil because pesticides or herbicides have not disturbed it.

Reasoning

Since fungi is ubiquitous, it is expected that soil will cause the culture plates to be near 100% coverage in fungi following 72 hours, according to microbiologists at Sul Ross State University. It is also expected that farmed soil should be near rangeland levels of fungi, if not for pesticides, fungicides, and herbicides.

Safety Precautions:

Care will be taken to look carefully before reaching for any plant during collection due to the presence of Western diamondback rattlesnakes on the South Plains.

During the culturing of fungus, goggles, and gloves will be worn. The lids on the Petri dishes were sealed carefully to prevent contamination. Work will be done under supervision.

Supervisors:

During this experiment, we were supervised during all procedures by:

- Laura Wilbanks, Team Advisor, supervised lab work
- Jude Smith, Refuge Manager, Muleshoe National Wildlife Refuge, supervised field work.

Materials Needed:

Plastic bags for soil collection
Field data forms and labels
Gloves
Goggles
Petri dishes
Saucepan and wood spoon
Hotplate
Nutrient agar
Triple beam balance
Beakers
Metric measuring spoons

Filtered water
Calculator
Shovel
Field guide
Camera
Thermometer
Incubator
Grid paper for counting colonies

Procedure for Gathering Soil Material:

1. Record all soil locations by using a GPS unit and Google Earth.

2. Collect 50 ml of soil from each location, being careful to select soil that is representative of the location identified.

3. Place each soil sample into separate, properly labeled Zip-Lock bags.

4. Label each bag with the name of the soil, the general location name, and record this in the field journal.

Procedure for Pouring Petri Plates:

1. Mass 12 grams of nutrient agar using a digital scale.
2. Add to 0.5 liter of distilled water and mix until evenly dispersed.
3. Heat with repeated stirring and boil for one minute to dissolve the agar completely.
4. Quickly and carefully tip the lid of the Petri dish open and add 1 ml of agar to the dish using a pipette.
5. Replace the lid and allow the agar to harden.

Procedure for Culturing Soil Fungus

1. Place 1 ml of soil on the surface of nutrient agar that is in Petri dishes.
2. Then, culture the plates for 72 hours.
3. Take pictures and record notes every 24 hours.
4. After the 72 hours, determine the amount of fungus on each plate using grid paper.
5. Convert the number of grids containing fungal spores into the percentage of fungus in each Petri dish.
6. Record data using tables, graphs, and charts.
7. Analyze each kind of soil for the amount of fungi present.
8. Record qualitative and quantitative data.
9. Record results, conclusion, and next steps in experimentation.

Controls:

- Follow the written procedures carefully for every sample used during the lab.
- Keep all measurements and timing the same in every sample of soil tested for fungi.
- A control Petri dish containing only agar and no soil will be tested alongside each soil sample being placed in the incubator so that a fair comparison can be made.

Constants:

- Follow the written procedures carefully for every sample used during the lab.
- Keep all measurements, temperature, and timing the same for every sample.
- A control plate will be tested alongside each soil sample. It will contain agar only, and no soil.
- Native rangeland soil will also serve as an additional control or standard alongside each sample being placed in the incubator because that soil will not have been disturbed or plowed and represents healthy soil.

Independent Variable:

- Follow the written procedures carefully for every sample used during the lab.
- Keep all measurements and timing the same in every sample of soil tested for fungi.
- A control Petri dish containing only agar and no soil will be tested alongside each soil sample being placed in the incubator so that a fair comparison can be made.

Dependent Variable:

The amount of fungi that grows during a 72-hour culture period will be measured by counting the number of grids that contain fungi and converting that number to a percent.

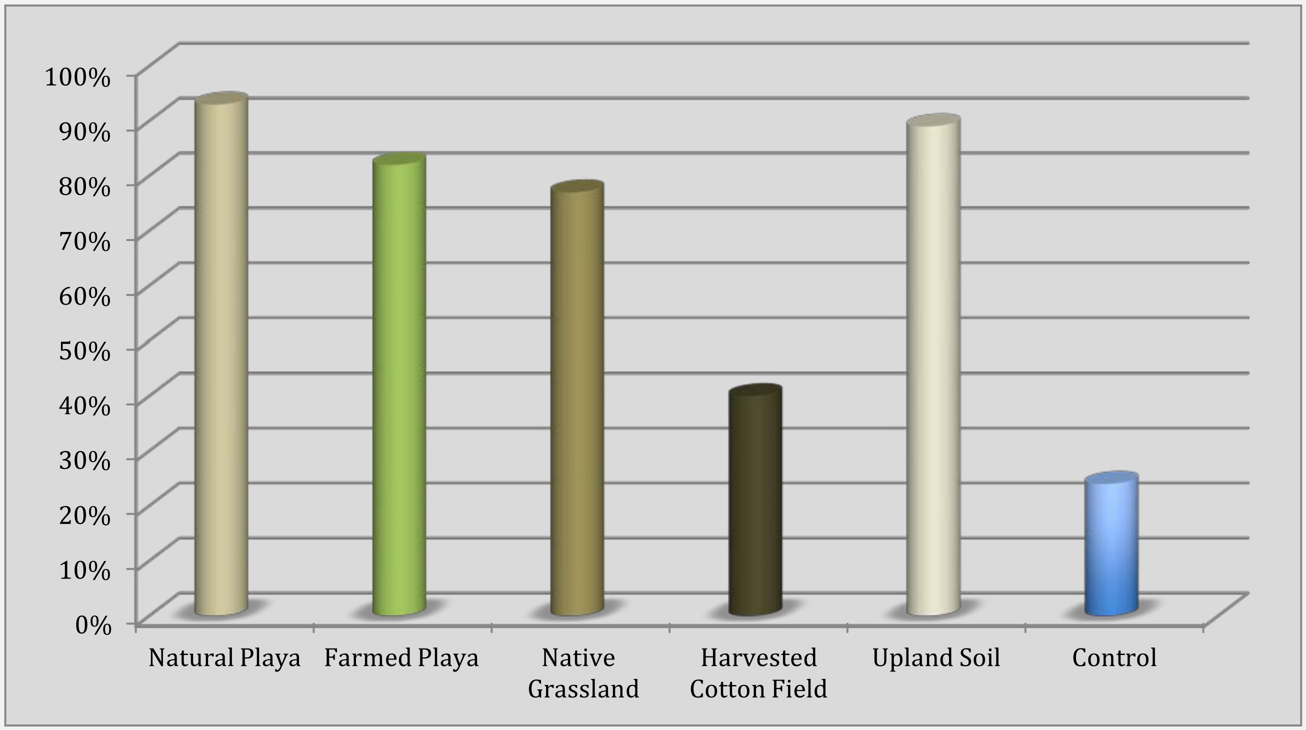
Quantitative Data Collected

Amount of Fungi Present in Soil - **Trial One**					
Soil Type	Location (GPS)	Amount of Fungi Present			Final %
		Rank at 24 Hours	Rank at 48 Hours	Rank at 72 Hours	
Natural Playa	33'35 49 N 102'38 22 W	2	1	3	91
Farmed Playa	33'35 50 N 102'38 15 W	4	4	1	94
Native Grassland	33'36 00 N 102' 38 20 W	3	3	4	56
Harvested Cotton Field	33'36 16 N 102'38 11 W	5	5	5	32
Upland Soil	33'36 01 N 102'38 21 W	1	2	2	89
Control	No Soil Added	6	6	6	24

Amount of Fungi Present in Soil - **Trial Two**					
Soil Type	Location (GPS)	Amount of Fungi Present			Final %
		Rank at 24 Hours	Rank at 48 Hours	Rank at 72 Hours	
Natural Playa	33'35 49 N 102'38 22 W	2	1	1	97
Farmed Playa	33'35 50 N 102'38 15 W	1	2	2	95
Native Grassland	33'36 00 N 102' 38 20 W	4	4	4	88
Harvested Cotton Field	33'36 16 N 102'38 11 W	5	5	5	37
Upland Soil	33'36 01 N 102'38 21 W	3	3	3	92
Control	No Soil Added	6	6	6	29

Amount of Fungi Present in Soil - **Trial Three**					
Soil Type	Location (GPS)	Amount of Fungi Present			Final %
		Rank at 24 Hours	Rank at 48 Hours	Rank at 72 Hours	
Natural Playa	33'35 49 N 102'38 22 W	2	2	1	92
Farmed Playa	33'35 50 N 102'38 15 W	3	3	4	56
Native Grassland	33'36 00 N 102' 38 20 W	1	1	2	88
Harvested Cotton Field	33'36 16 N 102'38 11 W	5	5	5	52
Upland Soil	33'36 01 N 102'38 21 W	4	4	3	85
Control	No Soil Added	6	6	6	18

Average Amount of Fungi Present in Soil -**Final Outcome**			
Soil Type	Location (GPS)	Amount of Fungi Present (Mean)	
		Final Rank	Final %
Natural Playa	33'35 49 N 102'38 22 W	1	93%
Farmed Playa	33'35 50 N 102'38 15 W	3	82%
Native Grassland	33'36 00 N 102' 38 20 W	4	77%
Harvested Cotton Field	33'36 16 N 102'38 11 W	5	40%
Upland Soil	33'36 01 N 102'38 21 W	2	89%
Control	No Soil Added	6	24%



Results:

We found out that the **Natural Playa** had the most fungus in it with 93% of the culture plates showing fungal growth. Our idea is that pesticides or herbicides weren't applied here, so the fungus in the playa is still present.

The **Harvested Cotton Field** had the least amount of fungus cultured, with 40% of the Petri dish indicating fungi. Since 1940, all the pesticides and herbicides that were being used on that field accumulated and did not leach out of the soil. These chemicals could have killed the fungus in that soil.

The **Native Grassland** had an average amount of fungus in it, 77%, because there were been tumbleweeds on that grassland so it have been plowed over at least one time over the 20 years or so. The Farmed Playa had a good amount of fungus in it, 82%, because it has been plowed over several times.

The sandy **Upland Soil** had a high amount of fungus in it, 89%, because it was on the road berm, basically. We were surprised about the amount of fungus found in the sand and how much life was in the sand. We think of sand as lifeless and so dry, but this was not the case.

Conclusions:

One soil was found to have the most fungus in it and that soil is Natural Playa soil. It had a 93% of fungus in it. It had a high amount of fungus because there was a buffer of grasslands around this area; therefore, the pesticides or herbicides will not run down into the playa wetland. The Harvested Cotton Field was found to have the least amount of fungus in it. It had a low amount of fungus because of all the pesticides or herbicides that have been used on that field, which could have killed most of the fungus on that field.

Applications:

Land that area ranchers want to turn back into short grass prairie should be checked for amounts of fungi present because fungi play a vital role in the health of grasslands. If the land has been used for farming during the previous 75 years, chemical residue will still be affecting the fungi levels in the soil. **If our team, Ants Go Marchin', can find a way to introduce fungal spores back into this depleted soil, the land will be healthier and the native prairie will recover more quickly.**

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Contact List

While all of these contacts contributed vital information to our team, the ones listed in bold type are most familiar with our project.

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The team is working with ants and UV lights

The team has been to the Aday Ranch to begin restoring native prairie

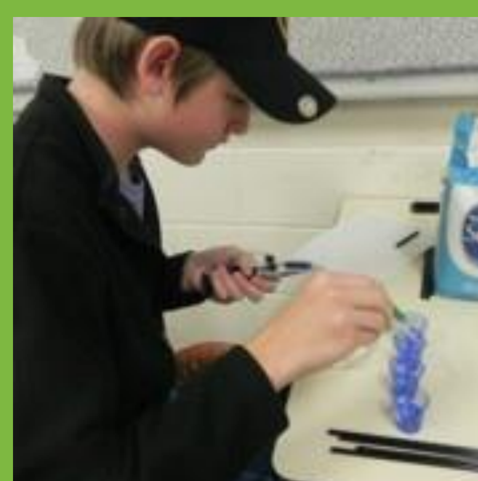
The team is heading to the fields to improve the health of soils

ScienceRocksU

Come hear the AMAZING

“ANTS GO MARCHIN'” team.

@3:30 p.m. Friday Feb 14, 2014



We had decided to coat the crop seeds with mycorrhizae and humic acid to help enrich the soil and also promote root growth. We decided to use these after watching an online video by Michael Martin Melendrez of *Soil Secrets* in which he tells a story of how he used these substances to enrich his soil.

LET NATURE DO THE WORK

We had an idea that we should let nature do the work of healing nature! We could use harvester ants to carry the mycorrhizae-coated seeds underground. The fungi would spread onto the roots of plants and improve both plant health and soil health. The ants would work and then let nature take care of healing itself.

ANTS GO MARCHIN' 2 BY 2

Ants Go Marchin' is a group of 7th graders worried about the fact that our county's soil is missing a beneficial fungi. We are looking for a way to put that fungi back into the soil to benefit farmers, ranchers, and the land itself.

SEED GERMINATION WITH MYCORRHIZAE AND HUMIC ACID

The Ants go Marching tested three crop seeds that are commonly planted in this region. Fungus called mycorrhizae and humic acid to help boost seed germination were applied to the seeds."

On the right are the data tables which include the results the team recorded."

Plant health is dependent on soil health!

MILO SEEDS:

Milo - Sorghum - Maize Seeds											
	Seedling Growth										
	1	2	3	4	5	6	7	8	9	10	Total Growth
Growth Medium											
Untreated	6.5	5.3	3.1	3.9	4.1	5.2	0	0	0	0	28.1
Myc + HA	5.9	2.3	5.2	0	0	0	0	0	0	0	13.4
Myc	6.5	3.2	8.1	4.1	0	0	0	0	0	0	21.9
Humic Acid	11	5.9	3.5	5.6	7.8	0	0	0	0	0	33.8

SUNFLOWER SEEDS:

Sunflower Seeds											
	Seedling Growth										
	1	2	3	4	5	6	7	8	9	10	Total Growth
Growth Medium											
Untreated	7.7	7.1	3.6	0	0	0	0	0	0	0	18.4
Myc + HA	7.6	5.4	3.6	1.8	8.2	4	0	0	0	0	31
Myc	11.2	2.5	6	0	0	0	0	0	0	0	19.7
Humic Acid	6.4	6.3	1.4	3.3	3.5	4.2	8.6	0	0	0	33.7

WHEAT SEEDS:

Wheat Seeds											
	Seedling Growth										
	1	2	3	4	5	6	7	8	9	10	Total Growth
Growth Medium											
Untreated	2.4	3.5	0	0	0	0	0	0	0	0	5.9
Myc + HA	1.8	1.1	0	0	0	0	0	0	0	0	2.9
Myc	0	0	0	0	0	0	0	0	0	0	0
Humic Acid	2.7	0	0	0	0	0	0	0	0	0	2.7

Aerial View of the Aday WTX Ranch

Areas of the 500 acre ranch are in need of grassland restoration because of past years of overgrazing by beef cattle. Our team will begin the process of seeding the area and spreading pellets coated in mycorrhizae for the ants to disperse as well. Areas for the control have already been fenced off and restoration is scheduled for April 2014.