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DATA Nugget

Microbes facing tough times

Featured scientist: Jennifer Jones (she/her) from the Kellogg Biological Station Long Term Ecological Research Site. Written with Melissa Frost and Liz Schultheis.

Research Background:

Jennifer sampling soil before the shelters were set up. Here you can see the control (left) and carbon addition (right) plots.

As the climate changes, Michigan is expected to experience more drought. **Droughts** are periods of low rainfall when water becomes limiting to organisms. This is a challenge for our agricultural food system. Farmers in Michigan will be planting crops into conditions that make it harder for corn, soybean, and wheat to grow and survive.

Scientists are looking into how crop interactions with other organisms may help. **Microbes** are microscopic organisms that live in soils everywhere. Some microbes can help crops get through time times. These beneficial microbes are called **mutualists**. They give plants nutrients and water in exchange for carbon from the plant. Microbes use the carbon they get from plants as food. If plants are stressed and don't have any carbon to give, microbes get carbon from dead plant material in the soil.

Jennifer is a biologist studying the role of microbes in agriculture. She has always been interested in a career that would help people. As a student, Jennifer thought she would have a career in politics. Along the way, she learned that a career in science is a great way to study questions that may lead to solutions for the challenges we are facing today. Jennifer was drawn to the Kellogg Biological Station, where she joined a team of scientists studying the impacts of climate change and drought on agriculture.

Jennifer and other scientists set out to test ways that we can give mutualists in the soil a boost. She thought, perhaps if we were to give microbes more food, they would be less stressed during a drought and would be able to help out crops growing in these stressful conditions.

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To test this idea, Jennifer needed to test how well microbes were doing under different carbon and drought conditions. First, she set up treatments in soybean fields to manipulate the amount of carbon in the soil. She set up control plots where she left the soil alone. She also set up carbon treatment plots where dead plant litter was added to the soil to increase the carbon available to microbes.

Next, Jennifer manipulated the availability of water in her plots to test the microbes under stress. To do this, she set up her plots under shelters that kept out rain. The shelters had sprinklers, which were automated to add specific amounts of water to the plots. This design allowed Jennifer to control the watering schedule for each plot. One shelter treatment was a control, where water was added to the plots every week. This is similar to the schedules of local farmers who add water through irrigation. The other shelter treatment was drought, where plots received no water for six weeks. This experiment was replicated 4 times, meaning there were 4 shelters on the control watering schedule and 4 shelters that were under drought conditions.

A view of one of the shelters used in Jennifer's experiment. Under each shelter she added two treatments – plots that were left as a control and plots where plant litter was added. This plant litter added carbon to the soil and could serve as a food source for microbes. You can see a small black sprinkler head in the middle of this shelter, showing it is one of the control irrigated shelters where water was added to plots each week.

Finally, Jennifer had to measure how the microbes were doing in each treatment. She did this by measuring their **enzyme activity**. Enzyme activity is a measure of how active the microbes are. The higher the enzyme activity, the happier the microbes are. To measure this, Jennifer collected soil samples from each plot throughout the growing season and took them to the lab to measure enzyme levels in the soil samples. These enzymes are made by microbes when they are active. She then calculated the mean of all her samples for each treatment combination.

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Jennifer predicted two things. First, if drought is harmful to microbes, then she would expect to see lower enzyme activity in the drought treatment compared to the irrigated treatment. Second, if adding carbon to the soil is a way to help microbes overcome the challenge of drought, she expected higher enzyme activity in the plots with plant litter added compared to the control treatment. Both of these taken together would indicate that drought is stressful for microbes, but we can help them out by adding resources like plant litter to soils.

Scientific Questions: How does drought affect soil microbes? Does the addition of carbon, in the form of plant litter, help microbes handle potential stress?

What is the hypothesis? Find the hypothesis in the Research Background and underline it. A hypothesis is a proposed explanation for an observation, which can then be tested with experimentation or other types of studies.

Scientific Data:

Use the data below to answer the scientific questions:

Shelter treatment	Soil treatment	Soil moisture (mean)	Soil moisture (SD)	Enzyme activity (mean)	Enzyme activity (SD)
Drought	**Control**	0.06	0.01	-1.68	1.55
Drought	**Plant litter**	0.05	0.02	0.12	1.61
Control	**Control**	0.12	0.03	-0.94	1.24
Control	**Plant litter**	0.12	0.02	-0.32	2.10

Mean = Average
SD = Standard Deviation

Note: There is more enzyme activity when values are higher. In Jennifer's analysis, negative enzyme activity just means that it was reduced compared to positive values.

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What data will you graph to answer the questions?

Independent variable(s): ____

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Dependent variable(s): ____

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<u>Draw your graph(s) below</u>: Identify any changes, trends, or differences you see in the graph. Draw arrows pointing out what you see and write one sentence describing what you see next to each arrow.

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Interpret the data:

Make a claim that answers each of the scientific questions: How does drought affect soil microbes? Does the addition of carbon, in the form of plant litter, help microbes handle potential stress?

What evidence was used to write your claims? Reference specific parts of the table or graph.

Explain your reasoning and why the evidence supports your claims. Connect the data back to what you learned about the role that microbes play for crop plants.

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Did the data support Jennifer's hypothesis? Use evidence to explain why or why not. If you feel the data are inconclusive, explain why.

Your next steps as a scientist: Science is an ongoing process. What new question(s) should be investigated to build on Jennifer's research? How do your questions build on the research that has already been done?

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