Name_____

DATA Nugget

Fertilizing biofuel crops may cause release of greenhouse gases

Featured scientist: Leilei Ruan from Michigan State University

Research Background:

Greenhouse gases in our atmosphere, like carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), trap heat from the sun and warm the earth. We need some greenhouse gases to keep the planet warm enough for life. But today, the majority (97%) of scientists agree that the levels of greenhouse gases are getting dangerously high and are causing changes in our climate that may be hard for us to adjust to.

When we burn fuels to heat and cool our homes or power our cars we release greenhouse gasses. Most of the energy used today comes from **fossil fuels**. These energy sources are called "fossil" fuels because they come from plants, algae, and animals that lived hundreds of millions of years ago! After they died, their tissues were buried and slowly turned into coal, oil, and natural gas. An important fact about fossil fuels is that when we use them, they release CO_2 into our atmosphere that was stored millions of years ago. The release of this stored carbon is adding more and more greenhouse gases to our atmosphere, and much faster than today's plants and algae can remove during photosynthesis. In order to reduce the effects of climate change, we need to change the way we use energy and think of new ways to power our world.

One potential solution could be to grow our fuel instead of drilling for it. **Biofuels** are a potential substitute for fossil fuels. Biofuels, like fossil fuels, are made from the tissues

Scientist Leilei collecting samples of gases released by the growing of biofuel crops. Photo credits: K. Stepnitz, MSU

An aerial view of the experiment at MSU where biofuel crops are grown.

of plants. The big difference is that they are made from plants that are alive and growing today. Unlike fossil fuels that emit CO_2, biofuel crops first remove CO_2 from the atmosphere as the plants grow and photosynthesize. When biofuels are burned for fuel, the CO_2 is emitted back into the atmosphere, balancing the total amount that was removed and released.

Scientists are interested in figuring out if biofuels make a good replacement for fossil fuels. It is still not clear if the plants that are used to produce biofuels are able to absorb enough CO_2 to offset all of the greenhouse gases that are emitted when biofuels are produced. Additional greenhouse gases are emitted when producing biofuels because it takes energy to plant, water, and harvest the crops, as well as to convert them into fuel. In order to maximize plant growth, many biofuel crops are fertilized by adding nitrogen (N) fertilizer to the soil. However, if there is too much nitrogen in the soil for the crops to take up, it may instead be released into the atmosphere as the gas nitrous oxide (N_2O). N_2O is a greenhouse gas with a global warming potential nearly 300 times higher than CO_2! Global warming potential is a relative measure of how much heat a greenhouse gas traps in the atmosphere.

Leilei is a scientist who researches whether biofuels make a good alternative to fossil fuels. He wondered what steps farmers could take to reduce the amount of N_2O released when growing biofuel crops. Leilei designed an experiment to determine how much N_2O is emitted when different amounts of nitrogen fertilizer are added to the soil. In other words, he wanted to know whether the amount of N_2O that is emitted into the atmosphere is associated with how much fertilizer is added to the field. To test this idea, he looked at fields of switchgrass, a perennial grass native to North America. Switchgrass is one of the most promising biofuel crops. The fields of switchgrass were first planted in 2008 as a part of a very large long-term study at the Kellogg Biological Station in southwest Michigan. The researchers set up eight fertilization treatments (0, 28, 56, 84, 112, 140, 168, and 196 kg N ha^{-1}) in four replicate fields of switchgrass, for a total of 32 research plots. Leilei measured how much N_2O was released by the soil in the 32 research plots for many years. Here we have two years of Leilei's data.

Scientific Question: In what way does the amount of fertilizer applied when growing biofuel crops affect N_2O (a greenhouse gas) emissions?

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.

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Scientific Data:

Use the data below to answer the scientific question:

Amount of nitrogen fertilizer applied * (kg N per ha)	N_2O emissions in biofuel fields ** 2009 (kg N_2O-N per ha)	N_2O emissions in biofuel fields ** 2010 (kg N_2O-N per ha)
0	0.30	0.26
28	0.50	0.55
56	0.64	0.68
84	0.85	0.98
112	1.11	1.29
140	1.26	1.59
168	1.41	1.90
196	1.70	2.91

*Amount of nitrogen fertilizer added was measured in kilograms (kg) of nitrogen (N) applied to 1 hectare (ha) of land.

** N_2O emissions were measured in kg of N, released in the form of N_2O, from one ha of land. This measure represents the total emissions during the study time each year (May to December). Each value is the mean of four replicates.

What data will you graph to answer the question?

Independent variable(s): _____

_____

Dependent variable(s): _____

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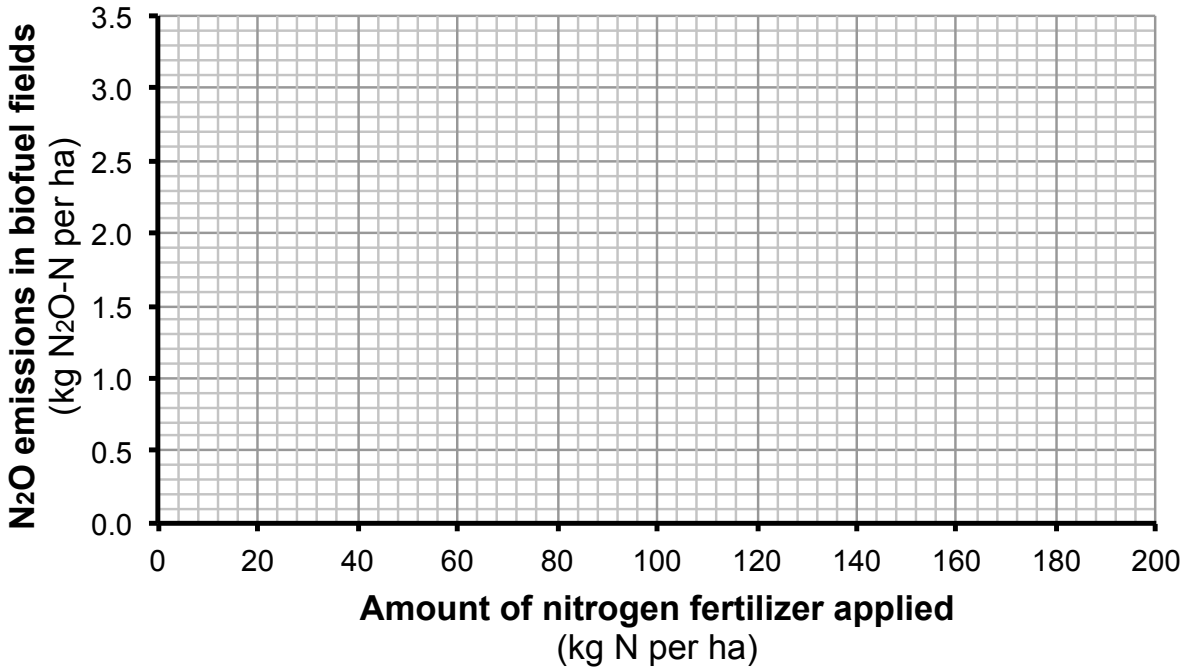
Name_____

Draw your graph below: Identify any changes, trends, or differences you see in your graph. Draw arrows pointing out what you see, and write one sentence describing what you see next to each arrow.



Interpret the data:

Make a claim that answers the scientific question.

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

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Explain your reasoning and why the evidence supports your claim. Connect the data back to what you learned about greenhouse gas emissions during biofuel crop production, and how this influences the suitability of biofuels as an energy source.

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

Your next steps as a scientist: Science is an ongoing process. What new question(s) should be investigated to build on Leilei's research? What future data should be collected to answer your question(s)?